MGIPC—S4—10 AR—21-6-49—1,000.

THE SCOTTISH

Journal of Agriculture.

VOLUME VIII.

1925.

EDINBURGH

PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:

[illegible], George Street, [illegible];
Adastral House, Kingsway, London, W[illegible];
[illegible], Abingdon Street, London, S.W.1;
York Street, Manchester; or [illegible], St. Andrew's Crescent, Cardiff;
or through any Bookseller.

EDINBURGH:
PRINTED BY J. SKINNER AND CO., LTD.

The Scottish
Journal of Agriculture

VOL. VIII.—NO. 1.] JANUARY 1925. PRICE 1s. NET.

SCIENCE AND THE FARMER.

Sir ROBERT GREIG, M.C., LL.D.

IN the course of a recent tour of some of the Agricultural Experiment Stations attached to Agricultural Colleges, University Departments and Government Experimental Farms in Canada the great benefit which has accrued to the Canadian farmer from the applications of science to his industry made a deep impression.

The criticism of an occasional observer that, while valuable work was being done in demonstration and experiment, the fundamental researches were not sufficiently encouraged, leads to a consideration of how agriculture is concerned with pure and with applied science. One often hears from a farmer that such and such an investigation is not practical, that it will not lead to useful results, that it is a waste of time and money. This is a natural but a short-sighted view. It is natural because a farmer who makes his living by applying science to his industry wants to see how he can make an immediate increase of profit or avoid a loss. It is short-sighted because all applied science is the outcome of pure research. If all scientific men were to devote themselves to the application of the results of research, and to ignore pure research, *i.e.* research without a practical object, the increase of knowledge would immediately be curtailed, and applied science would suffer accordingly. It is easy to cite examples of the practical benefits resulting from pure science. Researches upon the comparatively unimportant metal, selenium, have shewn the probability that through its reaction to light rays the blind will in future be able to read by sound a book in ordinary type instead of being compelled as now to read through touch the clumsy and expensive embossed type. Yet it is probable that nothing was further from the mind of the researcher than that this quite extraordinary benefit to the afflicted would come out of his research. In Canada competent authorities estimate that hundreds of millions of dollars have been added to the wealth of the world by the introduction of Marquis wheat. It may be said that Marquis wheat was the product of an agricultural experiment station, and so it was; but it was the fundamental knowledge of pure science, the science of botany, which enabled the investigator to produce Marquis.

It is true that the gains from research for its own sake are more numerous and spectacular in public health and in naval and military science than in agriculture. It is also true that some of the discoveries which have benefited agriculture have been due to

empirical experiments, such as the use of basic slag on suitable land or the inclusion of wild white clover in grass seed mixtures. But this is no argument for the neglect of pure science; rather is it an encouragement to attack the fundamental principles which lie at the roots of our farming methods, and without regard to immediate results, to believe that at any moment a great discovery may be made.

The great investigator is born, however, not made, though to some extent he can be trained, and it should be the object of a wise statesmanship to find and to encourage such men. This, then, is a plea for patience on the part of the farmer. Let him not regard too lightly or contemptuously the man of research. It may be that some obscure investigator after years of apparent failure will supply the piece that enables the scientist in Vienna or California to complete the pattern which as a whole will shake the world with a new idea. It is true at all events that in different parts of the world there are men working at questions of heredity and sex determination on snails or frogs or monkeys with no thought of the stock owners' problems, nor any interest in them, but building up such a body of knowledge that one day the breeder will breed colts or fillies, bulls or heifers, just as he may determine.

A little consideration will show that our present research institutions are based upon, and could not exist without, the foundation of pure science. The Rowett Institute at Aberdeen would be impossible but for the previous work of the physiologist, the chemist, and the bacteriologist. An investigation of the mineral requirements in the food of animals could not be undertaken if the pure chemist had not long ago, and without any regard for results, discovered the inorganic composition of the earth and the actions and reactions of its elements. But his knowledge would have been useless at this stage if the physiologist had not demonstrated the circulation of the blood and the processes of digestion and respiration. It is only in the light of such knowledge that it is worth while to ask such a question as what foods and combinations of food will produce the most rapid and healthy growth in an animal.

Without the physicist the experiments which are being carried out to-day on the effects of light upon growth would be impossible, and the hope now held out that the rearrangement of buildings and the judicious use of artificial light will add to the health and productivity of domestic animals would be unfounded.

The classification of soils into their superficial chemical and physical types is the result within the last century only, of the work of the geologist, the chemist and the physicist. A soil survey for the information of the farmer cannot be undertaken without a knowledge of, and a reference to, the discoveries of men who had no practical end in view, but only the craving to know.

Many of the new varieties of our farm plants are due not to agricultural experts but to Mendel, a priest who occupied his leisure by growing peas; De Vries, a Professor of Botany who experimented with marigolds and primroses; and Nilsson, a botanist who knew nothing of farming. These men blazed the trail, and our Plant Breeding Stations, from which, especially in

Canada and Australia, such marvellous economic results have been reaped, are the outcome of pure research.

Professor Arthur Thomson says "the deeply theoretical is seldom very far away from the intensely practical," and he cites Pasteur's work in this connection. Pasteur's early work was upon "Molecular Dissymmetry." He was interested in the two crystalline forms assumed by tartrates, right-handed and left-handed, and it was from a study of these, incited by a manufacturer who was puzzled by the fermentation of his commercial tartrate of lime, that Pasteur made his discovery of the fermenting micro-organism. Again it was "well contrived experiments to throw new light upon the question of spontaneous generation" that led to new ways of preserving foodstuffs. No two investigations could appear of less practical importance to the farmer than these. Yet it was these researches that produced the control of anthrax and hydrophobia, produced modern dairying, refrigeration and cold storage, modern surgery and modern clean milk. It is quite impossible to estimate the practical effects upon life and wealth of the discovery and demonstration of bacteria and their activities. The importation of meat and dairy products in their present volume would have been impossible if pure science had not shown how to control fermentation. It follows that without this knowledge the British stockfeeder and dairy farmer might have been able to command higher prices for his products to-day, but on the other hand the population of this country and therefore the market for his goods would have been much smaller. Moreover, if science has encouraged the imports, it has also supplied the means of meeting the competition.

At Rothamsted and other places investigations of the bacterial content of the soil are under way. It may seem a far cry from such laboratory researches to the growing of a more profitable crop of grain or roots, but knowing as we do that bacteria and other micro-organisms affect the soil fertility, knowledge of their number and behaviour becomes essential to an understanding of fertility. At Oxford experiments in cultivation are costing large annual sums, and are showing among other results that sub-soiling is highly profitable on some soils and useless on others. If we knew why this is so, a great light would be thrown upon the practical working of the soil. The time and labour of the chemist and physicist is therefore well spent on such an inquiry. In the Animal Breeding Research Station in Edinburgh experiments are proceeding on the inheritance of certain plumage colours and other characteristics in fowls. To the superficial observer they may seem useless, but the data obtained may result in the isolation of strains of high fecundity known as soon as hatched by their colour alone. At the same station investigations upon the physiology of reproduction involving the minutest microscopical work and the most delicate manipulations are described in language incomprehensible to the layman, but they are gradually enlightening us as to the cause and cure of sterility. The chemical analysis of the herbage from a foul sheep farm where the death-rate is high or the elaborate pathological work of the Animal Diseases Research Association may seem to have small connection with braxy or

louping ill, but it is in such fundamental work that the prevention or cure will be found. We are less ignorant than our grandfathers and less sceptical than our fathers, but some of us are perhaps still inclined to think that science cannot do much for agriculture. "Cannot" is a word that has often to blush for itself. "White oats cannot be grown in many parts of Scotland" said an old report, but only white oats are grown in these parts now. "Apples and alfalfa cannot be grown in Manitoba" they said thirty years ago, but apples and alfalfa grow in 1924.

The Canadian Government recognised long before the British Government the promise held out by science to the farmer. It was a chemist in a small country town in Canada who had the vision. His original scheme for experimental work can scarcely be improved upon to-day. This scheme was adopted by the Canadian Government, and the first experimental farm was set up at Ottawa. There are now some 25 experimental farms from near the Arctic circle to the fruit and vine growing areas of British Columbia and Ontario. The work of the experimental farms is organised and controlled by a Director in Ottawa. It includes the following fourteen divisions:—

1. Animal Husbandry.	8. Forage crops.
2. Field Husbandry.	9. Economic fibre.
3. Horticulture.	10. Chemistry.
4. Poultry.	11. Botany.
5. Bees.	12. Bacteriology.
6. Tobacco.	13. Illustration plots.
7. Cereals.	14. Extension and publicity.

Volumes would be necessary to describe the work. Only some salient impressions can be offered here.

One of the most striking is that obtained of the foresight of the Government in placing their experimental farms ahead of settlement. The authorities have not waited until an area was settled. An experimental farm has, where desirable, been started in sparsely settled areas such as the Peace River Country. By this means the settler when he arrives, instead of making his own experiments on the varieties of crops to grow and the best methods of their cultivation, finds the information ready for him, and is thus saved from expense or even disaster. Moreover he finds a centre from which he can purchase seed and stock suitable for the district. This is experimental work in its elementary form. It is the discovery as quickly as possible of the most suitable grains and roots to grow, the cheapest methods of feeding stock, and the most satisfactory breeds of live stock in the circumstances.

In a longer settled district the problems are less easy, and here we find the experimental farms testing different rotations, methods of seeding, of dry land farming, of arable crops for stock, of grass seed mixtures, of shelter belts, and even of manuring. In other districts where farming has been carried on for a century or more, the work more nearly approaches that of our own Research Stations, but with far greater funds and many times more staff. If the Dominion experimental farm at Ottawa is taken as the best example, we find wonderful work going on in plant breeding. The

Marquis wheat has already been referred to, but other new wheats that may prove even more suitable than Marquis for certain areas are soon to be on the market. Another section of the staff is concerned with forage crops, another exclusively with maize, improved varieties of which are in common use now, another with peas, another with apples, another with rhubarb or strawberries. The great expense of this work is amply justified when the area of each crop in Canada is considered, along with the fact that a 10 per cent. increase of crop would mean enormous additional wealth. The return upon national capital expended in this way is not ten or twenty or a hundred, but thousands per cent., and calculated thus the breeder of Marquis wheat is probably the greatest wealth producer of modern times, exceeding a Rockefeller, Vanderbilt or Henry Ford.

It must not be supposed that all the work of the experimental farms is of the directly applied or practical nature of the experiments described. The Canadians are aware of the necessity for fundamental research, and it is possible to provide a long list of investigations of no immediate practical importance which are being undertaken by the Government and by Colleges and University departments.

The peculiarities of the varied soils of Canada are being examined by the Chemical Departments. The fungoid diseases of crops are undergoing investigation by laboratory methods, the effect of light on plant growth, the influence of the ductless glands on animal growth and nutrition, and other equally elaborate and fundamental work is under way.

It is not enough for the Government to experiment and demonstrate in the manner described. For the purpose of bringing the results of the experiment stations to the notice of the largest possible body of farmers "Illustration" stations are organised and set up at more than 150 centres. A farmer who is interested in progressive agriculture and not indifferent to the benefits which will accrue to himself, provides the necessary land and labour. On this selected area the varieties of crops, the methods of cultivation and the value of good seed are presented in such a way that they illustrate the lesson which it is desired to teach.

In such and in other ways the information gained by trials or observations at the experimental farms is without delay—sometimes perhaps too hastily—brought to the notice of the farmer. For example, the famous poultry expert at the Ontario Agricultural College noticed that the hens which showed the greatest egg-producing powers in the numerous laying tests had as a rule certain characteristics of conformation, plumage and general appearance which distinguished them from poor layers. Ordinary farm flocks culled on these lines showed an increased egg production. Assuming that these observations were trustworthy, the question was how to give practical effect to them as quickly as possible. The method adopted was to invite a number of farmers, chiefly young men, to spend a short time at the College acquiring skill in recognising probable good layers. After this training the trained "cullers" are sent round the Ontario farms to assist the farmer in eliminating the unfit. The farmer or farmer's wife need

not accept the help, but as a rule he or she is glad to have it. The fowls are examined and the discarded have their tails cut off and in due time find their way to the pot or the poulterer, and the owner is instructed in the art of culling his own flock in future years.

What can Canada teach us in the way of research and experiment? Chiefly, it would appear, to be liberal with funds when men can be found who are capable of making the best use of them, and when results are obtained, to bring these to the notice of farmers as quickly and effectively as possible. The Publicity Department of the experimental farms carries out the following functions:—

1. Plans and constructs educational exhibits and stages them at fairs and shows.
2. Distributes literature at fairs.
3. Collects and edits material for the press.
4. Publishes "Seasonable Hints" every month and distributes them widely.
5. Prepares lantern slides and loans them for extension work.
6. Issues reports on the work of the experimental farms.
7. Prepares educational material for schools, lecture halls, libraries, etc.

Some of this work is being done now in this country, but on a very limited scale. What we can learn from Canada is to be liberal with our printing and publications. In one year the Publicity Department of the experiment stations sent short concise articles to 800 newspapers. These articles dealt only with one subject and were suitable for publication in the papers without revision. Canada believes that to spend great sums on experiments and then refrain from giving the results the widest publicity is to spoil the ship for a "ha'pworth of tar."

The way of the improver is easier in Canada than in a long settled community. There is no farming tradition in the newer parts of Canada. No one has any belief in the methods of his forefathers, and why should he, if his forefathers lived in Scotland or Sweden or Czecho-Slovakia? All are therefore ready to seek information and to apply it, and so a new and more profitable method is quickly adopted. In the experience of the writer, extending over thirty years of Canadian farming, the methods of cultivation, the rotations, the varieties of crops, even the implements of cultivation have changed. In Scotland long and hard experience has shown that on certain fairly defined lines fairly defined results can be obtained over an average of years. It is not surprising, then, that departures from traditional methods are slower and more cautious than in a new country. Moreover, it is not easy to overcome the handicap which the British farmer suffers from pursuing his occupation in an industrial country. In Canada, as in Denmark, Holland and other agricultural countries, the whole of the people are more or less interested in and more or less concerned with the condition of agriculture. An August frost in Manitoba is a calamity to every shopkeeper and business man in the Province. The discovery of an improved variety of wheat

is a cause for rejoicing in every Bank and Insurance Company and wholesale house in Canada. But in Great Britain the prosperity of agriculture is relatively of little importance. The result of the agricultural "atmosphere" in Canada is that many of the best brains of the country are continually reaching for better methods, better organisation, higher productivity, reduction of costs and improvement of stock and crops, and so research and education are liberally provided for. Our best farmers in Scotland and England are unexcelled in enterprise and intelligence and have nothing to learn from Canada, but even they would admit, and especially those who are engaged in public work for agriculture would agree, that their task would be easier if farming could recruit some of the brains that now go to commerce and industry, and if the general public regarded agriculture as of equal importance with coal-mining or engineering and equally worthy of support. But whereas mining and engineering can be trusted to make provision for research in private laboratories and public institutions, an industry composed of numerous small capitalists must look mainly to the understanding and consideration of the public to provide through public funds for similar assistance. It is this lesson that Canada has learned.

PRODUCTION OF PURE MILK.

R. H. LEITCH, M.A., B.Sc., N.D.A. (Hons.), N.D.D.

PROBABLY more has been written and spoken about this subject than about any other aspect of dairying, and yet, in spite of accumulated data, our evidence is far from being complete. The production of pure milk implies the elimination of all possible sources of contamination, and it requires only a superficial knowledge of milk hygiene to realise how extremely difficult such a task is. The object of this article is to direct attention to some special features in the production of milk which have a preponderating influence on its purity and healthfulness, and to proffer certain suggestions to those engaged in the dairying industry and in dairy investigations.

The first essential is that the cow should be healthy and free from all pathological defects. And yet if one were to exclude from the national milk supply the produce of cows which are tainted with tuberculosis, or are suffering from udder infections of a pathogenic nature, the amount of milk available for public consumption would undergo serious diminution.

We have got to face the fact that with the prevalence of tuberculosis in our dairy herds, and with the incidence of pathogenic streptococcus infections of the udder—which are much more widespread than even public health administrators realise—a universally pure milk cannot be offered to the consumer, and that until we are in a position to produce at a reasonable price a much more ample supply of milk on the certified standard, we cannot hope to obtain a full measure of public support in any projected campaign for the more extended use of milk.

While a discussion of bovine tuberculosis does not properly come within the scope of this paper, some suggestions as to the elimination of this deeply rooted disease from our dairy herds may be offered :—

First, the adoption of the Bang system, which has been successfully practised in Denmark (the segregation of calves from infected mothers at birth, and the rearing of the young on a tubercle-free milk in a healthy environment).

Secondly, the establishment of the accredited herd system which has found favour in America (the official registration and certification of herds in which all the component members have passed three semi-annual tuberculin tests).

Thirdly, the production of immunity by protective inoculation after the Calmette method, or by the use of detoxicated vaccines of the tubercle germ.

Fourthly, the rigid use of sires which have been shown by annual tests to be free from tuberculosis.

Fifthly, the efficient ventilation and lighting of the byre.

It should be pointed out that the risk of receiving a contaminated milk from cows affected with any form of tuberculosis is greater than is commonly supposed. As soon as the tubercle organisms get into the blood stream they will be voided in the dung, and hence milk may become indirectly infected through this channel long before the disease has appeared in the udder.

With reference to the presence of pathogenic streptococci in milk, experience would seem to indicate that this infection is of widespread occurrence and is actually on the increase among dairy stock. Attention has been directed to this trouble by frequent outbreaks of bad milk at creameries, and to the great difficulty of working the cheese-milk on certain dairy farms. The fault in most cases was found to be due to a form of contagious mammitis.

It requires the milk of only a few infected cows to contaminate a large volume of creamery milk or to upset the whole process of cheese-making. Such milk does not sour readily, but it usually develops an objectionable flavour. A peculiar feature of this milk is that it is more liable to secondary infections than ordinary milk, and that the utensils in which it has been handled are very difficult to sterilise. This disease does not readily yield to prophylactic treatment; recently good results have been reported from the use of autogenous attenuated vaccines.

Apart from these two common pathogenic infections one frequently finds in milk such undesirable organisms as *Staphylococcus aureus* and *Staph. albus*; *B. coli* of udder origin; *Str. pyogenes*, *B. enteritidis*, all of which are suggestive of inflammatory conditions of the milk gland.

Milk which has been altered biochemically by udder bacteria is difficult to handle in cheese-making. In fact it may be said that cheese-making will reveal minute changes in the milk more surely than any other test that has yet been devised. A high class cheese actually demands milk of a higher standard than good market milk.

The importance of the udder flora on the quality of cheese has been clearly established by Gorini, who suggests that cows should be selected on a basis of their mammary bacteria.

Environment.—The lighting and ventilation of the byre are important considerations in the production of pure milk. The majority of the byres in this country are much too dark, and darkness and dirt are boon companions. Roof lights are preferable to wall windows, and where the sashes of the roof ridge ventilator are sufficiently wide, all the light may come from this source. By a combination of adjustable inlets and a controllable roof ridge ventilator, an ample supply of fresh air may be maintained without making the byre draughty. A close stuffy byre not only militates against the production of clean milk, it makes the cows soft and flabby, udder troubles are more frequent, and the danger of infection in the case of tuberculosis is increased.

The cleaning of the byre is one of the mechanical operations which has much to do with the quality of the milk, and yet it is one of the points to which many dairy farmers pay too little attention. The byre should be cleaned twice a day and always after milking. Plenty of water should be used for washing the "grips" and passages. Explosive outbreaks of bad milk on some farms under our observation have in large measure been due to faulty cleaning of the byre, and the removal of the manure just before or during milking time. There is always a risk of contamination of this kind, especially when the cows are fed on rich or fermented foods.

Generally it will be found that the structural arrangements of the byres in a large proportion of our dairy farms are faulty, and while such conditions make the production of clean milk difficult, they do not make it impossible. There has been a tendency in past years to over-emphasise buildings and equipment and to underestimate methods of production, especially when the score card has been used as a guide. With careful supervision and the exercise of strict cleanliness in the matter of production and handling, it has frequently been demonstrated that a high class milk can be produced in ill-constructed and badly designed buildings. It is the personal factor that always counts. Nevertheless a bright, clean, easily kept byre is a great incentive to the production of pure milk, and when much labour has to be expended to keep the byre clean, less attention is likely to be given to other essential factors in milk hygiene.

The reconditioning of old and insanitary byres is a pressing need in many districts of Scotland. The necessary reconstruction need neither be very extensive nor costly. The fundamentally important requirements in addition to increased lighting and improved ventilation are sufficient standing space, a smooth-surfaced water-tight floor, and an easily cleaned, impervious manure channel. The judicious use of concrete will work wonders, and much can be done to improve the cleanness and internal brightness of the byre by the frequent and effective employment of whitewash.

The position of the dungstead with relation to the byre calls for passing comment. For hygienic reasons the manure heap

should be not less than 40 feet from the end of the byre. On many dairy farms the dungstead is so near the cowshed that contamination from this source is difficult to circumvent. Freshly drawn milk has the power of absorbing odours rapidly, and when the manure heap is in close proximity to the byre, the tainting of the milk by effluvia of the dungstead is of common occurrence. Moreover, the dungstead is a favourite breeding place of flies in summer, and when it is close to the end of the byre—a by no means uncommon arrangement—there is always a danger of a fly plague in the byre and in the dairy. Flies are a menace in two ways: first, they irritate the cows during milking, causing them to switch the tails violently, so that the chances of milk becoming infected with fæcal organisms are greatly increased; secondly, they contaminate the milk of themselves either by getting into it directly or by infecting the utensils. The organisms transmitted by flies are of a dangerous type—belonging chiefly to the colour-typhoid group. Hence the further the dungstead is from the main byre, the less is the attendant risk to the milk supply.

Cleaning and Caring for the Cow.—It is during the actual milking period that milk is most liable to contamination, and the careful preparation of the cow at this stage is immediately reflected in the lower bacterial count, and in the enhanced keeping properties of the milk. Where the highest grade of milk is sought, an actual washing and subsequent drying of the udder and flank and possibly of the tail is imperative, especially when diarrhœa is prevalent in the herd. This operation does not take so much time as might be imagined, and the care so expended is well repaid in the improved flavour and quality of the milk.

Next to actual washing, the wiping of the udder with a clean damp cloth is an effective procedure. The tendency here, however, is to scamp the work, and to continue to use the cleaning cloth after it has become soiled. Cloths after use should be washed and effectively scalded.

It is difficult to estimate the improvement in a milk supply which such a cleaning of the udder brings about; it is measured not so much in the reduction of bacterial numbers, though this is striking, as in the kinds of organisms—generally the worst type—which it eliminates. Comparative tests have shown that the washing of the cow's udder reduces the initial bacterial numbers in the milk by 80 per cent. A relative idea of the effect of cleaning the cow on the bacterial numbers in milk is conveyed by the following plate counts. Samples of milk from a cleaned and from an uncleaned cow belonging to the Station herd were cooled immediately after milking and kept at room temperature for 8 hours, when they were plated out. The milk from the uncleaned cow gave a bacterial count of 189,000 per c.c., while that of the cleaned cow gave a count of 5800 per c.c.

Milking.—Where hand milking is practised it is imperative that the milkers should wash their hands before milking each cow, using always clean water and a disinfectant soap. Milking should be done with dry hands.

The rejection of the foremilk is an important means of reducing the bacterial numbers in new milk. Foremilk usually has a

high count—we have found 25,000 per c.c. quite a common estimate—and when included in the milk acts as a starter of the worst possible type. At least three streams should be rejected from each teat. When gassy cheese is an occurrence it will invariably be found that the foremilk is highly contaminated with organisms of the coli-ærogenes type. As the foremilk is in any case low in fat (about 1 per cent.) little is lost by its complete rejection. The foremilk should be milked into a special pail and not projected on to the floor of the byre.

It is commonly asserted that the strippings are practically bacterial free, but repeated examination of the strippings has shown us that this seldom is the case. A *B. coli* count of 350 per c.c. and a total count of 650 per c.c. is not unusual. Strippings indeed frequently give a distinctly higher count than mid milk. The higher count is undoubtedly due to external infection from the teats rather than to an increase in the internal flora of the udder in the last drawn milk.

In all cases of infections of the udder the affected cows should be milked last, and such milk excluded from the milk churns or from the cheese vat, as should also colostrum for at least five clear days after calving.

The narrow top pail as a factor in the production of pure milk calls for passing notice. Experiences in America and in England have shown that by their use the bacterial contamination from the cow's coat can be very materially reduced. The drawback to their extended use is that the average milker requires some training to use them with the same degree of facility as the open pail. Besides many forms of protected pails that have been tried are of faulty construction. A good pail should neither be too high nor too broad. It should be of such a size that it can be held conveniently between the legs and easily pass under the udder of the cow.

Milking Machines.—In the matter of producing a clean milk, milking machines have fallen far short of general expectations. It is difficult indeed to get a machine-drawn milk with as low a bacterial count as milk drawn by the hand under hygienic conditions. The great drawback is that the rubber, besides being perishable, is extremely difficult to sterilise. The common antiseptics and disinfectants are of little service in sterilising milking machine parts. Before any disinfectant can be of service it must have penetrating power, and if this is inhibited by the greasy surface or by a caseous film on the internal walls of the rubber tubes, it cannot exercise any real sterilising effect. In any case most of the ordinary disinfectants have an injurious effect either on the rubber (as in the case of formalin) or on the metal teat cups (saturated brine formalin ammonium fluoride).

At present the only effective means of cleaning milking machines is a copious irrigation, first with lukewarm water, then with hot alkali water, and finally with boiling water. Unhappily the rubber commonly used by milking machine manufacturers will not withstand for long such rigid treatment. What is required is a heat resistant rubber with smooth internal walls, and so far this has not been made available. A modified treatment from

which good results have been recently obtained is that after a thorough washing with water and detergents, the milking machine parts are pasteurised in a metal tank to 80° C. for 20 minutes and left in this water until just before they are assembled for the milking.

In the hands of the average operator, milking machines are a real source of contamination in the milk supply, and are frequently responsible for high bacterial counts. In several recent outbreaks of bad milk on farms we have found the milking machines to be mainly responsible, due not to any inherent defect in their construction, but mainly to the lack of proper supervision and cleaning.

Feeding and Water Supply. — The food supply and the methods of feeding are factors in the production of clean milk which have received less attention than they merit. Apart from the temperature conditions of summer, which favour an increased bacterial development, and from the change of environment of the cow from stall to pasture feeding, there are certain milk infections which seem to be peculiar to the summer food supply. The rapid growth of young grass in early summer induces scouring and diarrhœa in the cows, and the inevitable soiling of the flanks and tail with a highly-infected fæces greatly increases the risk of polluting the milk. Under these conditions coliform infections are common. Hence, whenever scouring supervenes, prompt measures should be taken to counteract it. Scouring can easily be overcome by judicious prophylactic treatment.

Apart from the scouring effect of grass feeding, certain pastures are undoubtedly contaminated with organisms of a most undesirable type. We wish to direct special attention to this point, because as a source of infection the pasture has been somewhat overlooked. Low lying, damp meadows, heavily dunged pastures, and sewage irrigated fields are most troublesome, especially in wet seasons. The milk in such circumstances frequently produces a rapid gassy fermentation and a most disagreeable flavour, which is specially noticeable when dairy products, such as butter and cheese, are made from it. In the fluid condition the milk, even after immediate cooling, has poor keeping properties. The infecting bacteria are mostly of the coli-ærogenes group. What makes the infection of a serious nature is that the organisms get lodged within the udder, and even rigid cleanliness in the preparation of the cow and in the rejection of the foremilk are powerless to stop the trouble. For market purposes, effective pasteurisation is a remedy; the only preventive measure that can be adopted on cheese-making farms is entirely to exclude the cows from such pastures. Stagnant pools and ditches and dirty approaches to the pasture fields are subsidiary causes of bad summer milk. Stringy milk is often traceable to such sources.

Apart from pastures, certain bulky foods occasionally cause trouble in the milk supply. It seems difficult to produce milk of a low bacterial count with certain types of silage. Further, the milk of silage-fed cows frequently produces difficulties in cheese-making. The feeding of large amounts of wet grasses, of excessive quantities of roots or of unsound roots, or of musty hay and straw,

invariably results in a contaminated milk. The infection in these cases is usually external.

Unless great care is exercised fish meal is liable to produce a polluted milk, the infection in this case commonly coming from the clothes of the milker.

Cows fed on a high protein diet excrete a strongly-smelling dung, the flora of which is different from cows fed on an ordinary diet. Putrefactive bacteria are in greater numbers in the dung, and particles of such, reaching the milk from the cows' bodies, induce fermentations of a most undesirable nature.

A pure water supply is indispensable on the dairy farm. The drinking water should be above suspicion. A contaminated farm water is certain to infect the utensils, and water bacteria of this origin are of frequent occurrence, not only in milk but also in butter and in cheese. In all milk outbreaks at farms the water supply should be the first thing to be investigated.

Utensils.—Within recent years it has been demonstrated by many dairy investigators that the utensils are a prolific source of infection; indeed it is now held that the utensils are the commonest source of infection in market milk, and that every milk vessel tends to increase the bacterial count. Rusty utensils not only impart a metallic flavour to the milk, but on account of the roughened surface favour a secondary bacterial infection. It is difficult indeed to sterilise such utensils. In fact it may be said that such vessels are never properly sterilised under farm or factory conditions. The number of rusty milk churns now in use for transporting milk is surprisingly large. The retinning of such vessels is seldom an effective remedy; it imparts a false sense of security, because it merely hides a fault. Under ordinary conditions it is common to find that unsterilised utensils and unclean milk churns increase the bacterial count of market milk by almost unbelievable numbers.

A case in point may be quoted. A sample of pasteurised milk flowing from the cooler of a South of Scotland creamery was introduced into a sterile bottle (fitted with a ground glass stopper), conveyed to our laboratory and plated out within 24 hours of the taking of the sample. A specimen of the same pasteurised milk was drawn from a railway churn (into which the milk had been introduced for despatch to a distant city) and plated out at the same time. The bacterial count of the first sample was 6300 per c.c.; while that taken from the milk can was 1,290,000 per c.c.

The effective cleaning of milk vessels implies first a rinsing with cold water, secondly a scrubbing with hot alkali water followed by a rinsing with clean cold water, and thirdly an absolute scalding with boiling water or steaming for not less than one minute with a jet pressure of 25 lbs. An ordinary steaming for a few seconds such as is usually given is quite ineffective in inducing sterility. The lid and mouth of the can should receive the same thorough treatment. The important point is that after treatment the vessels should be so hot that they will dry rapidly and remain dry after sterilisation. Cans should be inverted on a clean drying rack well clear of the floor in a room with a good circulation of air. Wet cans are a source of gross contamina-

tion to the milk. Any adhering moisture also tends to rust the metal.

Cooling the Milk.—The rapid cooling of new milk is one of the best methods of promoting its keeping properties. By reducing the temperature of the freshly drawn milk to below 60° F. the development of the common souring germs is restrained to a marked degree, and the effective lifetime of the milk greatly prolonged. The important points in cooling are that the cooler should be of ample capacity, that it be quite free from rust and grease, and that it be thoroughly sterilised after use and copiously irrigated with boiling water just before it is again brought into service. A flushing with chlorinated water before use is also effective when boiling water is not available at the time. An ample flow of cold water should be maintained through the coils when the milk is being cooled.

While cooling aids the keeping properties of milk, it is no substitute for clean methods of production. The multiplication of lactose fermenters is merely restrained; the viable organisms themselves are not killed out. For example, the initial count of a sample of milk from a clean cow plated out within a short time of milking was 7000 per c.c. When the same milk was cooled to below 60° F. and held at that for 8 hours, the bacterial count was 5800 per c.c.; but as the death rate is normal, a reduction in numbers of this type is often experienced. Cooling has little restraining effect on many of the worst contaminating germs, especially of the putrefactive type. This is well illustrated in the successive counts of the milk of a very dirty cow. In this case the initial count was 51,000 per c c.; after a lapse of 8 hours, during which time the milk was kept well below 60° F., the bacterial count was 190,000.

Economic Aspect.—Clean milk production does not necessarily imply an increased oncost, but it does mean a higher degree of skill and intelligence among dairy workers and a keener interest in their work. Many of the worst mistakes in milk production have been found to be due not so much to obstinate and conscious carelessness as to a lack of knowledge of the fundamental factors which contribute to a pure milk supply. Dirty or contaminated milk always reduces the sales, and restricts the fuller use of milk by the consuming public. The amount of milk that becomes waste through faulty methods of production and handling is a serious economic loss to the industry. The loss falls mostly on the producer.

AGRICULTURAL RESEARCH IN SCOTLAND.

ALEXANDER M'CALLUM, M.A., LL.B.

REFERENCE has been made in previous articles to research work conducted at the Agricultural Colleges by members of staff in their respective lines of activity. Much of the work carried out by College officials has necessarily been more of the nature of

demonstration or experiment than of fundamental research. Investigations were, and are, regularly undertaken by the Colleges in manuring, testing of varieties of cereals and roots, and trials of feeding stuffs with the object of improving farm practice and applying locally results of investigations that may have been conducted elsewhere. While this is eminently useful work, it is not in its nature research properly so called, for that is aimed rather at discovering principles and scientific explanations of the phenomena of practice. Accordingly it was not to be expected from the College lecturers, whose time was almost wholly taken up in teaching, that they could devote much of their energies to pure research. Nevertheless, at all the Colleges some useful work of a more or less fundamental character has been undertaken and has been reported upon in College bulletins or in scientific journals.

Specific researches have also been made from time to time under the patronage of the Highland and Agricultural Society and also with the aid of Government grants, such as the investigation into louping-ill and braxy carried out by a Departmental Committee, appointed by the Board of Agriculture in 1901, of which Professor Hamilton of Aberdeen University was Chairman and Mr. (now Sir) R. B. Greig was Secretary and Demonstrator.

Such investigations, however, were somewhat sporadic in their occurrence, and were dependent mainly upon the enthusiasm of a few individual workers. The field was wide and only small portions of it were touched. But a new system was made possible in 1909 by the setting up and endowment of the Development Commission, which was to have as one of its main objects the aiding and developing of agriculture. In looking to the economic development of agriculture, the Commissioners naturally turned to research as one of the most promising methods of attack, and in a Memorandum issued in March 1911 they set forth their views regarding its organisation. Two alternatives were discussed—(*a*) to make grants for research on specific subjects, and (*b*) to assign permanent grants to institutions which would provide continuous employment for men engaged in research. The necessity for continuous work in agricultural research and the enormous advantage of team-work by trained and experienced investigators decided them to adopt in the main the latter alternative, while leaving themselves free to finance independent specific researches when this appeared desirable.

Accordingly they divided the field of agricultural research into eleven departments and indicated their willingness to assist permanent institutions to undertake investigations in one or other of these departments, viz.—Plant Physiology, Plant Pathology, Plant Breeding, Fruit-Growing, Plant Nutrition and Soil Problems, Animal Nutrition, Animal Breeding, Animal Pathology, Dairy Investigation, Agricultural Zoology, and Economics of Agriculture. Fifteen institutes were originally contemplated—of which one was to be in Scotland—and subsidiary stations were also provided for, but the original scheme has to some extent been modified.

A second branch of the organisation was the institution of scholarships in order to obtain trained scientific workers for the Institutes; a third made provision for assisting special researches

outwith the Institute scheme; and a fourth set aside funds to enable Colleges to employ expert scientific advisers for work among farmers within their areas.

All these four methods of encouraging research have been made applicable to Scotland. Institutions have been assisted to employ permanently whole time workers; temporary grants have been made to help the carrying out of definite pieces of research; a scheme of Advisory Officers has been instituted to provide technical assistance for the solution of practical farming problems; and a number of post-graduate scholarships have been awarded to promising students to help them to equip themselves for research work. The organisation is as yet too new for its efficiency to be fully tested, but it is obviously laid down on sound lines, and we are justified in looking forward to results which will be highly beneficial to Scottish agriculture. A short description of the various centres of activity as these are now in being is given.

ROWETT RESEARCH INSTITUTE IN ANIMAL NUTRITION, ABERDEEN.[1]

As already stated, the original scheme of the Development Commission contemplated that at least one of the permanent research institutions should be established in Scotland, and an understanding was arrived at in 1912 between the Scottish Education Department and the Development Commission that research work in Animal Nutrition should be associated with the North of Scotland College of Agriculture and the University of Aberdeen, the Commission very wisely insisting, not only in this instance but whenever practical, upon the co-operation of the scientific departments of the University and the technical staff of the Agricultural College. A Joint Committee, representative of the two institutions, was appointed in 1913 with four members from each body. The number of members was increased in 1922 to eleven, five from the University and five from the College, with one member co-opted. Principal Sir George Adam Smith has acted as chairman of the Committee from its inception.

To begin with, the scheme of work included, besides animal nutrition, research into bee disease and soil investigation, but these subsidiary branches were later transferred to the College, leaving the Joint Committee to deal with animal nutrition alone.

In April 1914 Dr John Boyd Orr was appointed to conduct the research work, which was then accommodated in the Agricultural and Physiological Departments of the University. The first intention was to house the Institute on the College of Agriculture estate at Craibstone, and the building was actually begun there in May 1914 of that part which was intended to be the right wing of the Institute. The outbreak of war two months later brought operations to a stand, and it was not until October 1919, when Dr Orr returned from military service, that these were resumed; the temporary premises were thereafter completed

[1] An article by Dr Orr on the Rowett Research Institute appeared in the issue of the JOURNAL for January 1923.

and equipped and a small staff of workers was appointed and took up duty.

Meantime, however, the ideas of the Joint Committee, under the inspiration of Dr Orr, had expanded, and in June 1919 a memorandum was submitted to the Board of Agriculture for Scotland and the Development Commission, outlining the work in contemplation, stating the land, buildings and equipment and the staff needed to carry it out efficiently, and estimating the capital and annual charges required. General approval was given by the Board and the Development Commission in October, and the Commission agreed to recommend the allocation of £20,000 towards the capital cost of land, buildings and equipment, which was put at £40,000 to £50,000, on condition that a like amount was obtained from other sources. A generous donor, Mr John Quiller Rowett, gifted £10,000, and the Joint Committee, with the sanction of the Government Departments concerned, thereupon proceeded to develop their scheme. The Craibstone building was equipped with two laboratories and other subsidiary accommodation and the work of the station was transferred there in the beginning of 1920.

One part of the extended plans for development was the provision of an experimental stock farm. Suitable land was not then available at Craibstone without encroaching unduly on the College activities. A convenient location for both Institute and farm was found near by, and the lands of Bridgefoot Farm and Redpool Croft were acquired by the Committee in November 1920, Mr Rowett making a further contribution to the Institute funds of an amount sufficient to meet the purchase price. Building commenced in April 1921, and on 12th September 1922 the Institute was declared open by H.M. Queen Mary in presence of a distinguished company representative of science, agriculture, and public administration.

The Institute is situated five miles north-west of Aberdeen, the nearest railway station, Bankhead, being about seven miles distant. The main building is on three floors and consists of laboratories, offices, library and stores, with accommodation for Biochemical and Metabolic, Physiological, Bacteriological and Pathological Departments. Near by are the Experimental Farm Buildings with piggery, byre, cattle house, stores, silo, metabolic rooms and workshop. There are also two cottages for the cattle attendants.

The land purchased by the Committee extends to 41 acres of light soil on a gravelly subsoil, but for the practical demonstration work in nutrition this is regarded as insufficient, and the Committee hope at some future stage to provide a farm of at least 200 acres. Meantime they have leased from the College the croft of Essiehill, extending to 54 acres—mainly rough hill, and have equipped it as a pig-breeding farm in order to provide the large supply of pigs which are used in the experimental work.

The lines of work of the Institute are stated to be (*a*) "investigations into the energy and material requirements of farm animals under conditions of maintenance and various kinds of production, and the best means of meeting these requirements; (*b*)

investigations into the constituents of and the digestibility and nutritive value of the various feeding stuffs." Such investigations obviously involve researches in biochemistry, physiology, bacteriology and pathology, and also practical tests upon the living animal. Hence the staff of the Institute embraces specialists in the sciences named, and necessarily also two or three members who are specially skilled in different branches of animal husbandry.

In the result the Institute is exceptionally well designed, both in staffing and in equipment, to deal with nutrition problems, inasmuch as the whole staff can work as a team upon a single problem, the different scientific workers having each their respective line of attack, while laboratory results or forecasts can be applied and checked by the practical feeder; and on the other hand, difficulties and problems which the latter may meet in daily routine can at once be investigated scientifically from different standpoints. So also different aspects of the same problem may be regarded simultaneously, as when metabolic researches and practical feeding experiments are utilised together in investigation.

It should perhaps be noted that the interest of the work is not confined to animal nutrition, as that phrase is commonly understood, since obviously the fundamental principles of nutrition are the same for humans as for the lower animals, and the results obtained are certain to throw light on human physiology and pathology. Thus it is now recognised that much of the ill-health or positive disease prevalent to-day is due to malnutrition, and the more the science of nutrition comes to be understood the more readily will these diseases be controlled. This aspect of the work of the Institute was specially in the mind of Dr Rowett, who made a plea that its function should not be interpreted too narrowly or confined too closely to stock-feeding problems.

One branch of the Institute requires special notice. In all scientific work it is essential that the worker should know what has been done in that particular line by other workers, his predecessors. The first duty of an investigator who proposes to take up a problem is to read up the literature of the subject and discover the extent of previous knowledge on it. For this reason an essential part of the equipment of such an institution as this is a library containing as complete a collection as possible of everything that has been published in any language dealing with the subjects of investigation. Thanks to the generosity of another benefactor, Mr Walter Reid, C.A., Aberdeen, who gifted £5000 for this special purpose, the Institute is in process of building up a reference library on animal nutrition in which it is hoped to make available, not only to members of staff, but to other scientific workers, all the known literature in this connection, so classified and catalogued as to make it possible for a worker to have full, accurate and easy reference to the published accounts of work done in any particular line. This will necessitate not only the collection of scientific journals and other publications, but also the careful abstracting and indexing of reports on the various subjects. Mr Reid's gift, together with a special grant from the Board of Agriculture for Scotland, has enabled the Committee of the Institute to provide accommodation and equipment for a library and to

appoint a librarian and statistician to look after this side of the work.

The staff of the Institute consists at present of the Director, Mr J. B. Orr, D.S.O., M.C., M.A., D.Sc., M.D., four heads of departments, three senior assistants, a statistician and librarian, a number of junior workers, and a small administrative staff.

As regards the progress of their work it is not proposed to attempt any detailed account. Much of the time of the Director and the senior staff has up till now been taken up with the designing and equipment of the laboratories and with preliminary investigation work and developing of methods. Nevertheless a surprising amount of useful research has already been accomplished and the reports of it published in various scientific and agricultural journals Thus, the importance of the presence of certain mineral substances in sufficient amount and proper proportion in the dietary of animals has been demonstrated, together with the harmful results brought about by their absence or deficiency. The value of various rations and the effect of variation in external temperature on the quantity of food required are being investigated by calorimetric methods; that is to say by measuring the output of heat from an animal under observation. From the amount of heat produced an indication is obtained of the amount of food being used up in the animal's body and the food requirements of the animal can thus be estimated At the Institute goats are being used in this investigation. Work has also been done on vitamins with pigs, fowls and sheep; on rickets in pigs and sheep; on variation in the composition of cow's milk; on the influence of extract of ductless glands upon milk secretion; on various nutritional diseases; and on the composition of proteins and their varying nutritive value. Practical feeding experiments have also been conducted with fish-meal as part of a ration for pigs: of cod-liver oil as a poultry food, of dried whey solids for pigs, and of other feeds. The poultry-feeding experiments have been carried out in conjunction with the staffs of the three agricultural colleges and most useful data have been obtained in this way, the co-operation of the Colleges permitting the experimental operations to be carried out on a much more extensive scale than would be possible at the Institute alone, and thus securing that more reliable data are obtained.

Some similar provision is an obvious requirement for experiment with larger animals. Before scientific results, which are got from work on a laboratory scale, can be announced to the public in order to affect farm practice, it is necessary to try them out in a commercial way with considerable numbers of animals. Accordingly the Committee of the Institute are anxious to secure such facilities by adding to its equipment a farm of 200 acres on which a large number of stock could be kept and dealt with as experimental material. To obtain this end further endowment is urgently needed.

NORTH OF SCOTLAND COLLEGE OF AGRICULTURE.

Soils Investigation.—Mention has been made of other lines of investigation undertaken by the Joint Committee of Aberdeen University and the North of Scotland College of Agriculture, but

later transferred to the latter body. The work on soils on the types of farming land in the north-east of Scotland is under the supervision of Professor Hendrick, with whom is associated Mr George Newlands, advisory officer. Besides the examination, physical and chemical, of soils, the investigation includes a study of drainage waters to determine the losses of fertilising material from soils under the conditions obtaining in the district. Gauges are attached to blocks of soil of known extent and the drainage waters collected from them are carefully analysed, the soil being cropped and manured according to the prevailing practice. Reports of the results obtained are issued at intervals.

Bee Disease Investigation.—Under Dr Rennie of the Zoological Department an interesting investigation has been carried on for some years into Bee Diseases, and one important result has been obtained in the identification of the mite which by infestation of the spiracles of the bee causes Acarine disease, apparently one of the phases of the so-called Isle of Wight disease. This investigation has been liberally supported by an enthusiastic bee-keeper, Mr Wood of Glassel, Aberdeenshire, who has made himself responsible for half the cost of the work, the other half being provided from Government funds. The investigation is being continued into methods of prevention and cure or control.

EDINBURGH UNIVERSITY AND COLLEGE OF AGRICULTURE JOINT COMMITTEE ON RESEARCH IN ANIMAL BREEDING.

The suggestion that work in animal breeding research should be undertaken at Edinburgh was made by the Board of Agriculture in 1913, and was considered by a Joint Committee representative of the University and the College in conjunction with the Board and the Development Commission. Some breeding work had already been done, mainly with sheep, by Professor Cossar Ewart of the University and by Professor Wallace and the staff of the College with cattle and sheep. The Joint Committee was definitely constituted in June 1913, and the lines of organisation and work were decided upon. But before anything further could be done the outbreak of war interrupted the activities of the Committee and these were suspended until late in 1919.

It was then determined that the work should be undertaken on a relatively small scale, that the smaller animals only should be used, and that operations should be extended gradually as opportunity arose and as trained workers were found. Dr F. A. E. Crew was appointed head of the station, and in February 1921 accommodation was provided in an old building in High School Yards, the property of the University. There office, library, laboratories and animal rooms were equipped and a small staff of workers was gradually got together.

The work of the station is mainly investigation into those problems of animal husbandry which are concerned with the physiology of reproduction and heredity. While the success of the British breeder in actual practice has been phenomenal, his methods have been mainly empirical, and the aim of the scientific investiga-

tor is by-and-by to substitute for these, so far as possible, assured methods of obtaining definite results, and to explain the natural processes involved.

One of the first lines of investigation undertaken was the possibility of fleece improvement in Blackface sheep. This was begun by a micrological study of the characters of wool, hair and kemp. Actual breeding experiments have been carried out on two lines—hybridisation and selection. In the former method Southdown rams were crossed with Blackface ewes, and the progeny and later generations are being carefully studied in order to determine the effects of this crossing. In the second method some work has been done by inter-breeding Blackface sheep which have been selected for special quality of wool in order to discover whether a strain of sheep may be obtained with a super-excellent quality of fleece and with their constitutional hardiness unimpaired. This wool investigation has now been extended to Welsh sheep and to Merino crosses, in the latter case by an arrangement come to between the English and Scottish Departments of Agriculture and the Woollen and Worsted Research Association.

Other problems under investigation are developmental intersexuality in the domesticated mammals, intersexuality in the fowl, sex-linked inheritance in fowls, the influence of the ductless glands upon development, the pathology of the bull-dog calf in the Dexter breed of cattle, and the factors involved in natural incubation of chicks. An inquiry has recently been commenced into the problem of sterility in cattle.

In addition to the regular staff, a number of voluntary workers have given valuable help from time to time in these and other investigations, and a large number of papers have been contributed to scientific journals.

Dr Crew is University Lecturer in Genetics, and in that capacity gives courses to students of pure, veterinary, and agricultural science.

While there are advantages in having the work carried on in close conjunction with the University and the Veterinary and Agricultural Colleges, the department is handicapped in its present location by lack of accommodation for the keeping of animals, and the Joint Committee with the approval of the Board of Agriculture have recently made arrangements for the transfer of the department to new premises at the King's Buildings, where ten acres of land are to be made available on the property of the University.

SCOTTISH SOCIETY FOR RESEARCH IN PLANT-BREEDING.

The proposal to set up a station in Scotland for research in plant-breeding was discussed at a meeting convened by the Directors of the Highland and Agricultural Society and held in their rooms on 26th July 1918. The meeting, which was presided over by the Right Hon. Robert Munro, K.C., M.P., Secretary for Scotland, was attended by representatives of the Society, the Scottish Chamber of Agriculture, the National Farmers' Union of Scotland, the Scottish Seed Trade Association, and the Board of Agriculture for Scotland. A resolution was unanimously adopted

approving the proposal and commending it to the support of the Board of Agriculture and of all interested in the development of Scottish Agriculture. Mr Munro promised to sanction the expenditure from the Agriculture (Scotland) Fund of an equivalent amount to whatever was obtained from other sources, up to a reasonable limit.

A Committee, under the Chairmanship of the late Mr Charles Douglas, C.B., D.Sc., of Auchlochan, was nominated to take the preliminary steps of bringing the proposal to the notice of the community and raising an endowment fund. By August 1920 a sum of £21,000 had been secured from voluntary contributions from Societies and individuals, and a constitution was thereupon drawn up for "the Scottish Society for Research in Plant-Breeding." The first meeting of Directors under this constitution was held on 6th September 1920, and the Society was registered under the Friendly Societies Act on 16th February 1921.

The objects of the Society were stated to be "the improvement of plants and crops in Scotland and the investigation of the conditions affecting their production." The results obtained by research and experiment in other countries such as Sweden, the United States, Canada, Australia and England have demonstrated the enormous economic advantages that may accrue, not only to the farmer, but also to the community as consumers, from the introduction of new varieties of farm crops, better suited to the conditions under which they are grown and possessed of qualities which make them more productive or less susceptible to disease. The evolution of a variety of oat suitable for high and late districts in Scotland or of a variety of potato immune to disease and of high cropping power and good quality, would obviously be of the utmost utility to Scottish agriculture; and it is to problems of this kind that the efforts of the Society are directed.

Membership of the Society is open, but while the number of subscribers to the endowment fund was gratifyingly large, the list of members is not nearly so comprehensive as it ought to be. It is to be remembered that the work is only at the beginning, and if it is to extend, as it ought to do, a sure and growing income is necessary. Donors of £20 or over to the funds may become life members; donors of £10 or over may become annual members by paying a subscription of 10s. yearly; other annual members pay £1. At the date of last Report there were 95 life members, 29 annual members at the 10s. rate and 58 at the £1 rate—182 in all. The affairs of the Society are administered by 5 Trustees and 25 Directors—18 ordinary, 4 nominated by the Board of Agriculture and 3 co-opted. The late Dr Douglas was Chairman from the constitution of the Society until his death, and he was succeeded in office by Mr James Elder, Athelstaneford, East Lothian, to whose personal efforts and enthusiastic advocacy much of the success of the appeal for the endowment fund was due.

This fund eventually amounted to £22,500, and, in accordance with the promise of the Secretary for Scotland, an equivalent amount was paid over in 1921-22 out of the Agriculture (Scotland) Fund; so that the fund available for capital expenditure and endowment came to £45,000.

An excellent location for the plant-breeding work was found at Craigs House, near Corstorphine, 4½ miles west of Edinburgh, where the Directors purchased a small estate, consisting of mansion-house, outbuildings, garden, two cottages and a grass paddock about 8½ acres in extent. At the same time they acquired from the Board of Agriculture two fields on the adjoining farm of East Craigs, which gave them an additional 27 acres of good arable land. Possession of the whole property was not obtained until Martinmas 1920, but, by arrangement with the tenant of the arable fields, a plot of three acres was taken over in the spring of that year and was sown out with a collection of oat varieties, which had been got together mainly through the agency of the Board of Agriculture. A collection of varieties of potatoes made by Professor Wilson of St Andrews University, then recently deceased, was also planted out. These crops were supervised during the summer by Mr James Robb, formerly Professor Wilson's assistant.

In the spring of 1921 Mr Montagu Drummond, B.A., F.L.S., was appointed Director of the Station and Mr Robb assistant Director and Secretary, the duties of Secretary of the Society being undertaken by Mr John Stirton, Secretary of the Highland and Agricultural Society.

The work of the Station is in the main on these lines :—

1. Collection and classification of suitable living material.
2. Isolation of pedigree strains (pure lines).
3. Comparative trials of varieties, pedigree strains, etc.
4. Hybridisation (crossing) of pedigree strains, varieties, and species.

The crop plants dealt with so far have been oats, barley, wheat, potatoes, turnips and swedes, and herbage plants, grasses and clovers. Details of the methods adopted and the results so far obtained are contained in the Annual Reports of the Director.

Purchase of the property and its equipment together with other initial outlays reduced the endowment fund to about £35,000, most of which is invested in Government securities. The income from these investments along with membership fees forms the present annual revenue of the Society; but in addition a Government grant is obtained which is not to exceed £1100 a year, and which, when added to the interest derived from the Board of Agriculture's contribution to the endowment, will not be more than two-thirds of the annual expenditure. Additional funds for equipment of the Station, for increased staff and for extension of the work are urgently desired by the Directors.

Other Agricultural Research work in Scotland will be described in an article which will appear in the April issue of the JOURNAL.

FARM PESTS—BIRDS.[1]

JAMES RITCHIE, M.A., D.Sc., F.R.S.E.,
Natural History Department, Royal Scottish Museum.

BIRDS AND GRAIN CROPS.

AT the mention of bird pests the farmer's thoughts turn as readily and naturally to his corn crops as the springtime youth's turn to love. It is here that he feels most acutely the attack of the birds, not because the loss of grain is necessarily more serious than the loss of poultry or lambs, but because the destruction of the corn crop is a continuous process. The damage is seldom due to a mass attack, once made and then forgotten, but resolves itself into a constant leakage which in the sum total makes a perceptible inroad upon the granary. Moreover the damage to the corn crop takes place under the eyes of the farmer, it is forced upon his notice; for whereas the birds of prey and the corbie tribe work in secret and on the outskirts of the farm, the grain destroyers are the commonest of birds, flocking about the homestead, and compelling attention to their depredations. Here, if anywhere, numbers become a vital part of the reckoning. As certainly as the seriousness of the loss caused by the stock-destroyers depends upon the individual value of each kill, as surely here the importance depends not on the thefts of the individual but on the plunder of the multitude.

At every stage of its development the grain crop lies open to attack. The seed-corn is raided by such as rooks and wood-pigeons; the sprouting blade is devoured by woodpigeons, sky-larks and starlings; even the green crop, the least vulnerable stage, suffers in a limited area of Scotland from the rapacity of wild geese, and some of the finches feed their young in part upon the milky ears. It is the ripening corn, however, which is most often associated with the destruction caused by birds, and which probably suffers most. Yet this does not complete the toll levied, since the stooks are raided by fresh bands of enemies, an odd assortment including rooks, some game birds, wild ducks and sea-gulls; and after the crop has been gathered the stubbles are picked clean by hordes of gleaners.

Were it not that the matter has been somewhat ignored in the statistical surveys of the food of birds, it would scarcely be necessary to point out that the grain obtained at each of these periods is not of equal agricultural value. The bird which steals a grain from the seed bed commits a theft many times more serious than that of purloining a grain from a ripened ear, for in the single seed lies the promise of a full head, of manifold return. The grain from the standing corn or from the stook stands in a different category from that gleaned from the stubble; the latter ought not to be reckoned against the gleaner at all, since it is already lost to the farmer. It may, indeed, have been shed from the ear through the

[1] Articles in this series, dealing with Mammal Pests, commenced in the JOURNAL in July 1922. The first article on Bird Pests appeared in January 1924.

action of one or other of the bird pests, but that is no reason for condemning the bird in whose crop it is recovered, simply because the method of crop-analysis, without field evidence, points its accusing finger at the wrong individual.

These remarks suggest that statistics of the grain content of birds' crops cannot be taken at their face value, and that here and there deductions and corrections must be made, if they are to reflect the real economic standing of any bird. I shall try to indicate in the following notes the seasonal incidence of each bird's misdemeanours, the general rule being that birds which are hard on the seed-bed are, grain for grain, much more serious pests than birds which are hard on the maturing or matured crop. On the other hand the numbers of most of the pests are greater during the summer and early autumn owing to the reinforcements due to the year's progeny, and this also must be taken into account.

The Bearing of Bird Migration on Farming.—So far as our account of bird pests has gone, the necessity of distinguishing between the resident birds of the country and the migrants has not arisen. The destroyers of farm-stock form a band few in kind and relatively few in number. In crop destruction, however, numbers are of the utmost significance, and the migration of birds resolves itself, from this point of view, into an influence which materially alters numbers at certain seasons. It is necessary, therefore, to indicate the bearing of bird migration on farming, a subject the importance of which has not been sufficiently appreciated in discussions on bird pests.

There are several directions in which migration may prove to be a factor of economic significance. In the first place, local movements (migration in miniature) of British birds may influence numbers of certain species at critical times, increasing or decreasing them at periods when their numbers may be either useful or harmful. In the second place, immigration from overseas may increase numbers of certain pests at seasons when they are destructive to crops. In the third place, such immigration may increase numbers at seasons when the particular pest species is doing little or no harm. And finally, immigrating hordes of birds may be destructive, while the true British residents are innocuous; and *vice versa*.

The unravelling of these economic influences is of practical value, particularly in relation to the destruction of bird pests. If the destruction attributed to a particular species is due, not to British residents, but to individuals merely passing through Britain on their way to other lands, clearly the destruction of the resident birds does not meet the case. Here only the birds on passage should be dealt with, though that might adversely affect the agricultural economics of the lands whence they came or whither they are going—a matter for international enquiry and regulation. Or again, the numbers of an undoubted British pest may be temporarily reinforced by alien individuals at a season when the species does no harm to crops, when, on the contrary, the activities of the birds may be of agricultural utility. The destruction of such invaders would at best be futile—it might be stupid.

Bird migration in Britain is a complex of many different movements, of which three in particular are most closely associated with agricultural affairs. In many instances, however, the members of a particular species may be involved in several different movements, so that it is difficult, if not impossible, to distinguish local residents from birds which have moved from another area, either within the country or beyond it. I shall indicate in a general way, with the aid of a few examples, how each of the three types of migration referred to plays its agricultural part.

First. *Local Movements.*—Many birds which may be reckoned true British residents do not remain in one locality throughout the year. They take part in a kind of limited migration, a more or less local movement, from the summer breeding haunts to the winter haunts, and backward again in spring. Two examples may be cited. Rooks forsake their outlying summer rookeries, where nesting has taken place, to congregate in large winter roosts—the winter congregation taking place generally about the end of September, the spring dispersal from the winter roost in March. Lapwings, on the other hand, may leave their nesting haunts in Britain for southern countries abroad, but the majority of British-bred birds remain in this country, many moving from the higher ground to the sea-shore, where they appear in flocks.

Such winter movements have the effect of altering the distribution of certain birds at a time when the grain crop is off the ground, and when they could carry out their beneficent activities without the risk of doing harm, so far as grain is concerned. In the case of the rook they mean that concentrated feeding tends to take place in particular areas during the winter, and sparser feeding in the neighbourhood of the summer nesting haunts. This must mean increased destruction of ground insects near the winter roost, but if these be scarce or unobtainable during frost or snow, probably unwelcome attention is paid to turnips and winter crops.

The winter movements of the lapwing are of special interest in view of the importance of the bird to agriculture and its steady decrease in its agricultural breeding grounds throughout the country. In the winter, shore shooting is legally permissible and is common. On its behalf, with respect to the killing of the lapwing, it is stated that such shooting cannot affect the British stock of breeding birds, as the shore population is largely composed of immigrants from north and central Europe. While it is true that there is a considerable influx of continental lapwings, which remain on our shores throughout the winter, it must not be forgotten that many, probably most, of the British breeding birds are there also; and that, since there is no way of distinguishing natives from immigrants, persistent shore shooting is bound to reduce the home-breeding stock. For this reason the winter shooting of lapwings should be discouraged.

Local movements, which are very largely connected with food supply, are taken part in by the majority of our birds, if we admit such minor changes of habitation as are shown by the sparrow, when it forsakes the town streets to fall upon the country harvest fields, or by many birds, including such as chaffinches, greenfinches and corn-buntings, some resident individuals of which leave their nest-

ing haunts to flock about farmyards in winter. Each such movement has some bearing on the agricultural activities of the birds, the flocking of the seed-eaters, for example, means that their chief winter work of economic importance, the destruction of weed-seeds, tends to be concentrated about the centres of cultivation.

Second. *Spring Migration.*—The spring migration is the return northward or eastward of birds which have wintered south or west of their nesting areas. In Britain it is signalised by the departure of many winter visitors, and by the arrival of hosts of birds which have spent the colder months in southern Europe or in Africa. The time of departure of winter visitors is of agricultural significance, in that it delimits the period of their activities, and must be considered in relation to the crops in the ground during their temporary sojourn—a matter further to be referred to in discussing autumn migration. The majority of the British spring arrivals from the south consists of British-bred birds which are returning to their old nesting quarters. These settle down in the country, their activities, which coincide with the great crop-raising season, are under observation, and the birds can be dealt with as occasion demands; so that, though many are of great agricultural importance—some lapwings, skylarks, the corncrake, the flycatchers and warblers, the swift and the swallow tribe and many others—their significance lies in their presence as summer residents rather than as migrants.

But there are large numbers of immigrants which do not settle down, and which make use of Britain merely as a source of food-supply on their journey to other countries northward or eastward. They are seldom dilatory on the northward journey, but it must be noted against those which destroy crops that they offer no compensation for their destructiveness. Most resident birds feed their young largely on injurious insects, and so make amends for a certain amount of harmfulness, but the bird of passage offers no such reparation. Among the migrants which pass through the country at the critical period when the grain crop is sown and has begun to sprout, and which have been convicted of damaging it, are such as rooks, woodpigeons, starlings and skylarks. As a rule the passage migrants follow later than the settlers of the same species and tend to keep in companies, otherwise they offer no distinguishing mark. These nomadic tribes must be judged by a standard different from that applied to resident individuals. The slaughter of them will not affect the breeding stock or progeny raised in Britain, though it will affect those of other countries. On the whole, since their passage through any district is a rapid one, probably scaring them off the most vulnerable crops is the simplest and cheapest method of dealing with them.

Third. *Autumn Migration.*—The autumn migration, a medley of comings and goings, comprising at least six distinct types of movement, interests us here mainly on account of three of these: the departure of summer visitors to their southern winter quarters, the passage of migrants on the journey from further north to further south, and the arrival of winter visitors from northern and central Europe. The kinds of birds involved in these three movements differ to some extent. The birds of passage may almost be

ignored: they include many species represented amongst our summer nesting birds, swallows, martins, fieldfares, as well as other more distinctively northern breeders, such as the arctic tern, curlew sandpiper, white-headed and grey-headed wagtails, but the short autumn sojourn of the birds on the through journey is of little economic importance. The departing summer visitors, typically represented by the swallow and martin, the swift, cuckoo, warblers and corn-crake, are almost wholly insectivorous. The incoming winter visitors, which include ducks, geese and swans, gulls, many waders, rooks, starlings, woodpigeons and many others, are able to subsist on a vegetarian or at least less exclusively insectivorous diet, or, if they are wholly insectivorous, confine their feeding to the sea shore or lakes.

On the whole the general effect of the autumn migration in Britain is to reduce very largely the number of insectivorous birds. This is a matter of some importance. The regular migrants are not necessarily compelled to leave because of the scarcity of the insect life on which they subsist; they depart with little reference to the particular conditions of any year. As a rule the bulk of the insects do disappear from view during the colder months, remaining concealed and hibernating, in one stage or another, in cracks of bark, under vegetation or in the soil. But in a mild winter when insect activity is less definitely arrested, multiplication may go on merrily, safe from the control of the insectivorous birds of which the country has been depleted by emigration. An open winter, coupled with the absence of most of their bird enemies, affords an opportunity which insects make the most of, to the detriment of the crops of the succeeding year.

Of the autumn migrants, the most important, from the farmer's point of view, are the arrivals from northern and central Europe. Some are regular migrants appearing at approximately the same season each year, others are more casual wanderers, driven southwards or westward at any time during the winter months by stress of weather conditions and lack of food. So far as the grain crop is concerned, the significance of these winter visitors depends largely on the date of their arrival and the date of their departure. If birds addicted to vegetarian diet arrive in Britain after the corn has been harvested and depart before the spring sowing, the only grain liable to their ravages is autumn sown wheat, a limited and rather local crop in Scotland. They may, however, turn in their need to root crops, and there is evidence that immigrant gulls, woodpigeons, rooks and even ducks are increasingly attacking potatoes and turnips in autumn and winter.

Some of the early autumn immigrants, however, do reach this country before all the corn is harvested, and these are responsible for an amount of damage by no means negligible. Amongst these must be included grey lag-geese, which, arriving in the Outer Hebrides towards the end of August in considerable flocks, beat down the standing oats with their wings, destroying more than they devour. So also the common wild duck or mallard, reaching Scotland a little later, from about the 12th of September to the end of the month, arrive in time to fall upon the stooks; and the more dilatory rooks and woodpigeons, which arrive from the end of

September to mid-October, the latter sometimes in almost countless numbers, should they chance to be too late for the last of the grain crop, are, at any rate, in good time for the roots.

The winter visitors begin to depart from Britain in March and continue their emigration throughout April and the early part of May, so that as their coming just overlaps the last stages of one year's corn crop, their going overlaps the first stages of that of the succeeding year. The periods of these overlaps, however, are relatively short, and there remains by far the longest portion of their sojourn, almost half the year, when, except for autumn sown grain, some greens and roots, the land is bare of crop. What are the bird visitors doing during this blank period? A large number seldom leave the sea-shore, but of the inland birds, many spend their time hunting out and devouring the hidden grubs and pupæ of insects, and when frost or snow deprive them of their source of livelihood they turn, some culprits to roots, but the majority to weed-seeds, to the hips and haws of the hedgerow, the refuse of the farm and the town, the gleanings of the fields and the stackyards. Over all, I believe that the winter visitors perform a vast amount of good in excess of their harmfulness, and the importance of their labours is increased in an open winter, when insect life, released from the threat of the summer insectivorous birds, threatens to run riot.

The relations of resident and migrant individuals to the grain crop will be more precisely indicated in the succeeding account of specific grain pests. Following the plan adopted in dealing with the other types of farm pests, the grain destroyers will be discussed roughly in the order of their destructiveness, but for convenience of reference and to avoid repetition they will be grouped in short series indicating their natural relationship.

The Pigeon Tribe.—The three species of pigeons or doves which affect the grain crop—the ring-dove, the stock-dove and the rock-dove—do so in very different degree, not because their food preferences are dissimilar, but because their distribution and numbers differ greatly. They stand out amongst British birds on account of several distinctive characters. Most easily recognised are the soft warm grey of their plumage, so characteristic that it has given its name to the shade "dove-grey," and their peculiar flight, strong regular wing-beats, occasionally interrupted by a more rapid flicker, driving them forward in headlong precipitancy. These are combined with relatively large size, for the smallest is over a foot in length, while the largest, the ring-dove, exceeds 16 inches; and in each the head is small in proportion to the body.

Other common structures include a rather weak compressed beak, having only the swollen tip of firm horny texture, and bearing at the base of the upper mandible a soft fleshy mass pierced by the nostrils. Although the wings are covered with rigid feathers, which can turn shot from its course, the plumage as a whole is soft and readily shed, and its gloss and gleams of metallic green and lilac add to the attractiveness of its colour. The wings are long and powerful and are capable of giving a sharp blow, being used by the birds in their combats; the tail is large and has twelve feathers.

As well as structures, our three pigeons possess certain habits in common. Though they are ground feeders they walk rather cumbrously, and cannot run with speed; they are almost wholly vegetarians, but do not scrape for their food like poultry; they prefer a water bath to a dust bath, and they drink, not in sips, but with a deep draught. They are monogamous, and remain paired for a succession of years, if not for life; yet they are seldom solitary, and are generally to be found nesting and feeding in bands. The social instinct of stock-doves even leads them frequently to associate with wood-pigeons. Two eggs is the rule in a clutch, and these are brooded by the male and female alternately. The young, born almost naked and helpless, are fed by both parents, first upon a thick fluid, "pigeon's milk," the cast-off lining of the crop, and afterwards by food softened in the crop. During the process of feeding, the nestling pushes its bill within that of its parent. It ought not to be forgotten that the "cooing" of pigeons also is characteristic.

The Wood-Pigeon or Ring-Dove.—More familiarly known in Scotland as the cushat, cushie-doo or simply cushie, the wood pigeon or ring-dove is the commonest and most destructive of British pigeons.

WOOD-PIGEON OR CUSHIE-DOO.[1]

From the others it may be distinguished by its greater size, 16½ inches in length, with wings 9¾ inches long, by a patch or line of creamy white on the side of its neck, the origin of the name ring-dove, and a patch of white upon the shoulder of the wing, the

[1] From Saunders' *Manual of British Birds*, by courtesy of Messrs Gurney and Jackson.

outer wing-coverts. As a breeding bird the wood-pigeon is to be found throughout the British Isles, building its rude nest of sticks usually at some height in a tree. In recent times it has increased in numbers, and, with new boldness, has invaded even the busiest cities.

The wood pigeons which breed in Britain do not migrate abroad in any number, but the approach of winter is signalised by the advent of hordes of immigrants from northern continental Europe. Some are merely birds of passage on their way to southern Europe and northern Africa, and such reach this country, according to Dr W. Eagle Clarke, between 25th September and 10th November, the bulk of the movement taking place in October. A greater number, however, have been driven southwards by lack of food, and remain during the winter in Britain if food and weather conditions favour their stay. In certain years the numbers of such winter visitors are almost beyond belief. A correspondent on the coast of Moray recently informed me that amongst many flocks seen arriving across the Moray Firth during the winter of 1923-24, he observed on 20th December 1923 a flock which he "estimated to be about fifty yards wide, while at either end it extended beyond the limits of vision." Additions of so great magnitude must obviously have a very drastic influence upon the wood-pigeon's winter food supply in Britain; the vital question is whether this food supply is one that affects the farmer. The winter visitors leave Britain in February or early March.

Economic Importance.—Wood-pigeons are almost wholly vegetarians. The crops of a few have been found crammed with harmful caterpillars and with slugs, but these are exceptional cases. As a rule they feed upon seeds or green leaves. Amongst the former they show preference for acorns, beech-mast, hips and haws, weed-seeds and grain; amongst the latter for the leaves of trees, of turnips and many other farm crops.

At every stage of its growth the grain crop is at the wood-pigeon's mercy. Before the spring sowing takes place the winter visitors have mostly fled, but the resident birds pick grain from the newly sown fields. A little later they receive the assistance of the passage migrants on their way northward through Britain, mainly in April and May, in devouring the fresh blades of the sprouting grain. The green corn suffers perhaps less than any other stage, but the respite is more than balanced by renewed attacks upon the ripening ears, and especially upon the corn in stook. During the spring-to-autumn period of the grain crop, the wood-pigeon is exceedingly destructive and offers no serious compensation for the damage it does. Indeed, to its grain damage must be added the destruction it causes during this period to young turnips, clover and such crops as beet, peas, vetches and the like. Its harmfulness from spring to early autumn is universal throughout the country.

Most investigators have condemned it utterly, irrespective of time and place; but its winter activities deserve special consideration. They vary according to the agriculture of the district, and are enormously increased by the influx of the migrants already mentioned.

In areas where autumn wheat is sown, and where winter crops, such as cabbages and rape, are in the ground, it is exceedingly destructive. On this account it must be condemned, even in winter, in the greater part of England and in a small area in Scotland. It also attacks potatoes in their season, eats turnip tops, and "holes" the turnips themselves so that they are liable to decay. No mercy need be shown here. But there is a period in winter when potatoes are not available, and, in Scotland, places where root and green crops are absent or scarce. Here the wood-pigeon, in its vast winter numbers, may do good worth reckoning. In the woods its diet of acorns and beech-mast is innocuous, but in the fields it devours seeds of many weeds, including charlock, runch, ragwort, spurrey, chick-weed and dock. On this account it is possible that in certain types of agricultural areas it should not be regarded as a pest during the winter months. The point can be finally decided only by examination of the crop contents of birds collected regularly in such areas throughout the winter months.

In any case the shooting of immigrants cannot affect the summer breeding stock, which in all arable areas ought to be kept down. The general opinion regarding the activities of the bird is indicated by the fact that the Board of Agriculture for Scotland has received complaints regarding its depredations from eighteen Scottish counties, ranging from Sutherland to the Solway Firth.

COLOUR HEREDITY IN HORSES.

H. B. STIRLING, Darlingfield, Berwickshire.

IN animal breeding there is an uncertainty about the results to be expected from the mating of individuals which contributes in no small degree to its fascination, but there are few breeders who have not felt the limitation of knowledge and have consequently been oppressed with a sense of groping in the dark. Until the publication of Mendel's work in 1900 scientists had offered little help except in theory, but a new impetus was then given to investigators as Mendel supplied a practical basis for further experiment. Most pure breeds have been founded by mating individuals bearing certain desirable characters and evolved by more or less inbreeding and selection thereafter, but this has been accomplished by the genius of the selector and without any knowledge of the laws which govern heredity. In all cases it has been a slow and costly process, and any increase of knowledge which makes the end aimed at easier of attainment is to be welcomed.

Much good work has been accomplished in the crossing of the smaller animals with results which point to the universal application of Mendel's principles to all animal breeding, but the higher the scale of the animal the more difficult research work becomes owing to the complexity of characters in each individual and the influence which certain characters exert upon each other. The

greatest difficulty which confronts the breeder of animals on Mendelian lines is the problem of inbreeding. Mendel worked mostly with plants, which under natural conditions were self-fertilized, and this difficulty did not therefore enter into his calculations, but with the larger animals it becomes very real and with none more than the horse. The first essential in any breed of horses is strength of constitution, for upon this depends the power of nutrition and the resulting stamina, and every practical breeder knows that there is no influence which will more quickly undermine the constitution of a horse than continuous inbreeding. In experimental work where it is not necessary to consider the utility of the produce this might be overlooked, but for the fact that loss of constitution affects certain characters more than others, size and weight for instance, and the results obtained where such characters have been affected may therefore be misleading. On the other hand, if inbreeding is to be avoided and crosses mated together, the number of animals requiring to be bred to get the requisite number unrelated and with the same number of crosses would make the work impossible from an economic standpoint. Private enterprise can only carry out experimental work on an economic basis, but this may not always be a drawback, as it means progress along useful lines, whereas there is often much needless waste involved in cases where economy does not require to be considered.

It is on economic lines that the following experimental breeding has been carried through, and, although the temptation was sometimes very great, the testing of the males had to be abandoned as the expense of keeping them entire for experimental purposes was prohibitive. For the same reason, although nearly all females were tested, only those which were themselves good animals and proved useful breeders were retained. From the scientific standpoint the results are therefore incomplete, but they are sufficiently interesting to warrant their publication in the hope that they may prove of value to the practical breeder and form a basis for further investigation. As the records date back to 1878 some explanation is necessary as to how they came to be begun and continued on systematic lines. The light grey mare Jess proved to be of exceptional merit and a winner of many prizes in the local showyards. It was decided to breed from her, and by using only registered Clydesdale sires ultimately to get the family registered in the Clydesdale Stud Book. Grey, however, is not favoured as a Clydesdale colour, and with a view to eliminating the greys only bay, brown or black horses were used. On the publication of Mendel's work in 1900 it was recognised that the end aimed at might have been achieved much sooner by mating the first crosses, but considering how much had already been accomplished and the dangers of inbreeding where the experiment had to be conducted on economic lines, it seemed advisable to continue on the same system if only to demonstrate the results to be obtained by the continuous mating back to the one registered line. That these results are capable of a Mendelian interpretation there can be no doubt, but, as the number of individuals is too limited to allow of accurate conclusions being reached, no attempt is made to arrive

at deductions which might prove to be erroneous. References to Mendelism are, therefore, only for the purpose of illustration or comparison, and the terms used, such as "pure line," are not to be construed in the sense in which they are known to the scientific worker.

Throughout the experiment all foals, except a few of the earlier ones, were registered in the year of birth, and the records can therefore be verified by reference to the Clydesdale Stud Book. In the case of those not registered, or when the colours given are not similar to those registered, these records can be vouched for by more than one individual who knew them to be the true colours of the mature animal. In the case of the stallions used, the colours given are those registered in the stud book, but no importance can be attached to the distinction between bay and brown, as much confusion existed among breeders as to which was the darker, and many of the bays were undoubtedly brown and many browns were nearly black. The difference between these colours appears to be a variation between the extremes of bay and black, the various shades of brown forming the intermediate group.

The foundation of the experiment was a dark grey mare purchased at Perth in 1878 in foal to the Clydesdale horse Lord Nelson (1202). An attempt was made in later years to trace her origin but without success, except that she had come from the south through dealers. As there was a regular trade in English mares at that time, and this mare bore all the characteristics, it was concluded that she was of Shire breeding. Her progeny, the light grey mare Jess, was therefore regarded as the first generation from a cross between the Shire and the Clydesdale, and subsequent breeding would appear to confirm this. The colours dark grey and light grey proved to be quite distinct and could be distinguished at birth, the dark greys being dark brown and very difficult to distinguish from the browns, while the light greys were of a light mousey colour. Throughout the whole course of the experiment these colours did not vary, the dark grey invariably possessing black fore legs and becoming dappled at from four to eight years and never really becoming wholly white with age, while the light greys were white at five years or even earlier. Unfortunately no photographs exist of the original mare or her daughter Jess, but the distinction in the colours is seen in illustrations 1 and 2.

The accompanying tables give the breeding records of the mares, while the chart shows the complete record of colours as they appeared in each generation. The mating of the dark grey Shire mare and the brown Clydesdale horse produced the light grey mare Jess. This mare bred 5 foals all by brown horses.

TABLE I.

Dark grey Shire mare. **Bay Clydesdale Lord Nelson (1202).**

Light grey mare—Jess.

Breeding Record of Jess.

Year.	Sire.	Colour of Sire.	Progeny.	Name.	Stud Book Reference.
1886	Oliver Twist (3043) ...	Brown.	Brown colt.		
1889	M'Vicar (5204)	Bay.	Dark grey filly.	Diana Vernon.	Vol. 17, p. 93.
1890	Fail Me Never (4362) ...	Brown.	Light grey colt.		
1892	Darnley's Hero (5697) ...	Bay.	Light grey filly.	Madge.	Vol. 22, p. 87.
1893	Prince Darnley (8133) ..	Bay.	Light grey colt.		

Of these 1 was brown, 1 dark grey and 3 light grey. Two of the greys were fillies, Diana Vernon, a dark grey (Illus. 1), and Madge, a light grey (Illus. 2), and they were of quite opposite types and distinctive colouring. Only the fillies were tested, and of the two Diana Vernon proved the more erratic breeder and only bred 4 foals, 1 brown, 2 dark grey and 1 dark chestnut grey.

TABLE II.

Breeding Record of Diana Vernon.

Year.	Sire.	Colour of Sire.	Progeny.	Name.	Stud Book Reference.
1894	Williamwood (8391) ...	Bay.	Bay colt	.	Vol. 17, p. 93.
1896	Gallant Poteath (8638) ...	Bay.	Dark grey filly.	*Lucy Ashton.	Vol. 19, p. 78.
1898	Cawdor Cup (10,045) ...	Bay.	Dark chestnut grey colt.	.	Vol. 21, p. 74.
1901	Royal Carrick (10,270) ...	Bay.	Dark grey colt.	..	Vol. 24, p. 89.

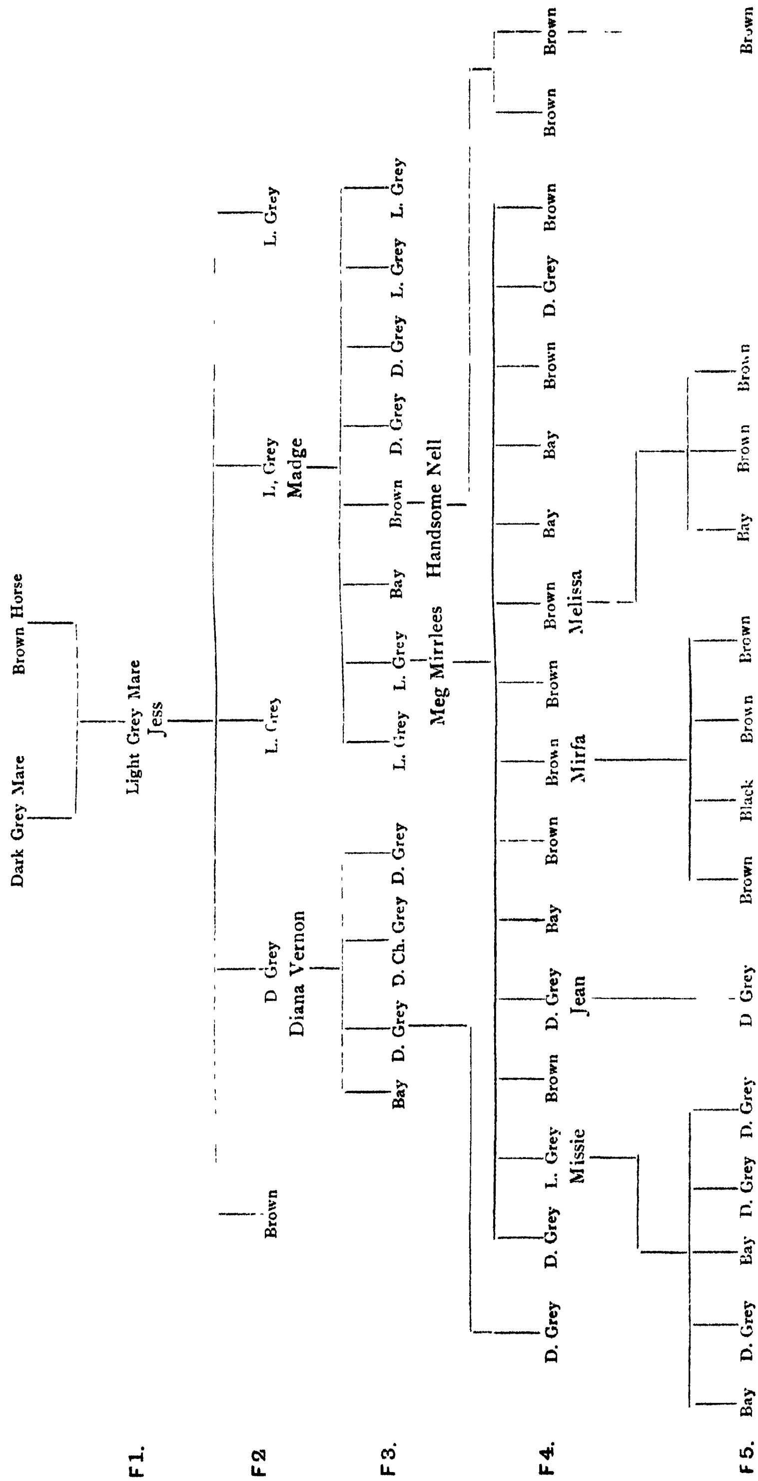
Note.—* Lucy Ashton (17,202) bred one filly by the brown horse Fashion Plate (10,746), also dark grey. (Vol. 28, p. 397.)

Of these the brown, one dark grey and the chestnut grey were colts and were not tested. The dark grey, Lucy Ashton (footnote to Table II.), bred one foal to a brown horse, also dark grey, but as both proved undesirable they were not bred further. The dark chestnut grey colt was by a sire whose dam was a chestnut mare with a Shire cross in her pedigree, and which could not therefore be considered as a pure bred line. This colt is mainly interesting for the influence of the introduction of the colour chestnut. Out of more than fifty individuals bred during the course of this experiment this was the only case of mixed colouring.

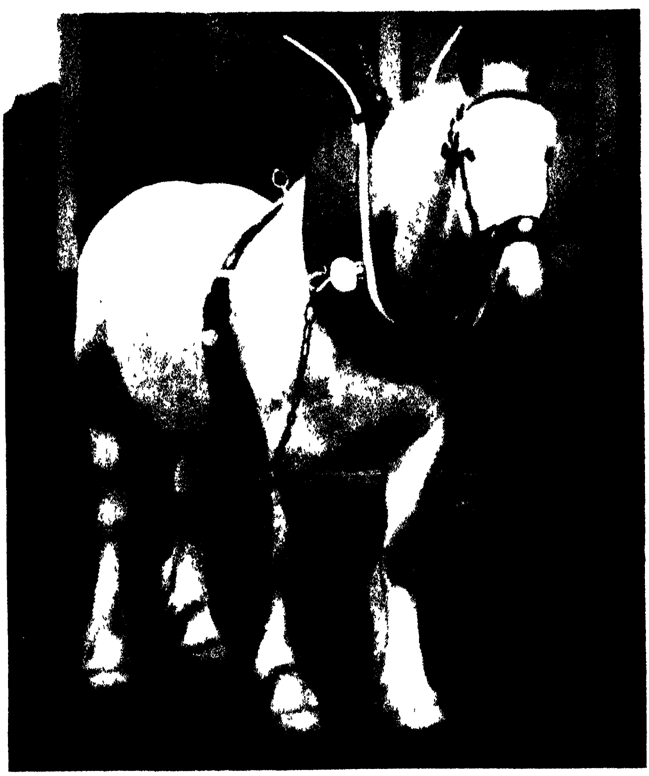
By the time that Diana Vernon had finished breeding, the light grey mare Madge had bred two foals, a colt and a filly, both light grey and by bay and black horses respectively. Up to this point the effort to breed out the greys had been conducted in the belief that, by the introduction of the blood of brown sires only, the grey would be eliminated according to the ideas of the fusion of blood then prevailing.

The results were so far not encouraging for this theory, and the publication of Mendel's work at this time changed the whole outlook and gave an added interest to the breeding, although it was not then known that Mendel's laws could be applied to the larger animals. Before the record of Madge was completed it

CHART GIVING SEQUENCE IN WHICH COLOURS APPEARED, READING FROM LEFT TO RIGHT.



ILLUS. 1.—DIANA VERNON AT 3 YEARS
A typical dark grey



ILLUS. 2.—MADGE AT 4 YEARS

Illus 3 Melissa

Dam light grey

(Illus 3 and 4 full sisters by brown horse, with white hairs through coat and much white on legs)

Illus 4 -- Mirfa.

Dam light grey.

became clear that there was no fusion of colouring, and that the colours grey and brown were Mendelian characters and were inherited separately. It was also clear, from the limited number of browns, that grey was the dominant character, but that a distinction would have to be drawn between light grey and dark grey, as they were breeding differently. The light greys had bred all the three colours, brown, dark grey and light grey, but no light greys had appeared from the dark greys. If Mendel's principles had been known sooner, it is probable that some of the earlier foundation crosses would have been interbred, as the objective of this breeding experiment was to eliminate the grey colour, but at the same time to retain certain desirable characters of the outcross. As it was too late to revert, it was decided to continue mating back to the pure Clydesdale line, and there was the added interest of finding out what effect mating back to brown would have on the greys and if both greys could be eliminated in this way.

The light grey mare Madge proved a more regular breeder and produced 8 foals.

TABLE III.

Breeding Record of Madge.

Year.	Sire.	Colour of Sire.	Progeny.	Name.	Stud Book Reference.
1897	M'Meekan (9600)	Bay.	Light grey colt.	. .	Vol. 22, p. 87.
1899	Prince Cedric (10,253) ...	Black.	Light grey filly.	Meg Mirrlees.	Vol. 22, p. 87.
1903	Balmedie Queen's Guard (10,966)	Bay.	Bay colt.	...	Vol. 26, p. 107.
1904	Boreland Pride (10,318) ...	Bay.	Brown filly.	*Handsome Nell.	Vol 27, p. 118.
1905	Do. do. . .	Bay.	†Dark grey filly.	..	Vol. 28, p. 139.
1908	Baron o' Dee (11,264) ...	Brown.	Dark grey colt.	...	Vol. 31, p. 207.
1909	Tomahawk (13,809) ...	Bay.	Light grey colt.	. .	Vol. 32, p. 242.
1913	Olinthus (17,407)	Bay.	Light grey colt.	..	Vol. 36, p. 217.

Note.—* Handsome Nell (21,377) bred a dark brown colt by the bay horse Tunic (13,816) (Vol. 31, p. 436), and a brown filly, Handsome Miss, by the bay horse Baron M'Nee (12,462). Handsome Miss (41,073) produced a dark brown colt by the brown horse Northumbria (16,734) (Vol. 39, p. 413).

† The dark grey filly failed to breed.

These were all to brown horses except the filly Meg Mirrlees, which was by a black. The black was not used intentionally, but the brown horse to which she was to be mated had been substituted by a black and no other was available. As black is recessive to brown and grey this did not influence the course of the experiment. The colours of the 8 foals from Madge were 2 brown, 2 dark grey and 4 light grey, one of each colour being a filly. This was the first opportunity of testing all the colours from one mare in the female line, but, unfortunately, the dark grey failed to breed. The brown, Handsome Nell, bred browns only, and a filly from her bred one foal also brown. (Footnote to Table III.)

The record of the light grey, Meg Mirrlees, proved the most interesting of the whole course, as it gave the first indication of the influence of the continuous use of brown sires. She bred 14 foals, and of these 10 were brown, 3 dark grey and 1 light grey.

TABLE IV.

Breeding Record of Meg Mirrlees (15,823).

Year.	Sire.	Colour of Sire.	Progeny.	Name.	Stud Book Reference.
1903	Balmedie Queen's Guard (10,966)	Bay.	Dark grey colt.	..	Vol. 26, p. 272.
1905	Boreland Pride (10,318) ...	Bay.	Light grey filly.	Missie.	Vol. 28, p. 139.
1906	Do. do. ...	Bay.	Brown colt.	..	Vol. 29, p. 189.
1908	Baron o' Dee (11,264) ...	Brown.	Dark grey filly.	Jean.	Vol. 31, p. 207.
1909	Tomahawk (13,809) ...	Bay.	Bay colt.	...	Vol. 32, p. 242.
1910	Baron Leven (12,459) ...	Brown.	Brown colt.	...	Vol. 33, p. 191.
1912	Beau Buchlyvie (16,474) ...	Brown.	Brown filly.	Mirfa.	Vol. 35, p. 195.
1913	Do. do. ...	Brown.	Bay colt.	. .	Vol. 36, p. 217.
1915	Do. do. ...	Brown.	Brown filly.	Melissa.	Vol. 38, p. 228.
1917	Olinthus (17,407)	Bay.	Bay filly.	Monica.	Vol. 45, p. 234.
1918	Do. do.	Bay.	Bay filly.	Moquette.	Vol. 41, p. 281.
1919	Lovat Chief (19,186) ...	Bay.	Brown colt.	...	Vol. 42, p. 293.
1920	Craigie Fascinator (19,683)	Bay.	Dark grey filly.	Merrythought.	Vol. 43, p. 275.
1921	Royal Success (20,175) .	Bay.	Brown filly.	Megan.	Vol. 44, p. 238.

Compared with the records of Jess and Madge, there is a marked change in the ratio of the colours, the browns having increased at the expense of the light greys, while the dark greys have remained constant. This result from continuously mating back suggests that it might be possible in the larger animals to get the requisite number of desired new combinations of characters without resorting to the Mendelian system of inbreeding by mating the first crosses. The noteworthy features in the record of Meg Mirrlees are the single light grey and the constancy in the number of dark greys. It was fortunate that the light grey was a filly, and, although she was not bred beyond five foals, these give a fair indication of the colours she transmitted.

TABLE V.

Breeding Record of Missie (24,342).

Year.	Sire.	Colour of Sire.	Progeny.	Name.	Stud Book Reference.
1909	Tomahawk (13,809) ...	Bay.	Bay filly.	...	Vol. 32, p. 802.
1910	Saladin (14,831)	Brown.	Dark grey filly.	..	Vol. 33, p. 191.
1913	Olinthus (17,407)	Bay.	Bay colt.	...	Vol. 38, p. 217.
1916	Do. do.	Bay.	Dark grey colt.	...	...
1918	Do. do.	Bay.	Dark grey colt.	...	...

Her record shows 2 bays and 3 dark greys, but no light greys, and it would seem not unreasonable to conclude that she was the last to bear the light grey colour considering that her dam only bred one light grey in fourteen. The light grey would therefore appear to be bred out in four generations, and it is of interest to note that this mare bore a colour which she did not transmit.

Regarding the dark grey borne by the light grey mare there is no evidence to show that its transmission could be in any way influenced by the continuous mating back to the brown, as in all

cases it reappeared in almost the same proportions, and it would therefore appear that the dark grey could not be bred out by a progressive grading, but could only be eliminated by selection.

Owing to their undesirable character or erratic breeding the dark greys were not sufficiently tested to give reliable data, but so far as tested they have bred true to their dominant grey character.

TABLE VI.

Breeding Record of Mirfa (40,056).

Year.	Sire.	Colour of Sire.	Progeny.	Name.	Stud Book Reference.
1915	Prince Ossian (16,004) .	Bay.	Brown colt.	. .	Vol. 38, p. 575.
1916	The Pilot (18,561)	Black.	Black filly.	Marcia.	Vol. 39, p. 228.
1917	Olinthus (17,407) ...	Bay.	Brown colt.	.	Vol. 40, p. 235.
1918	Dunure Luxury (19,108) ...	Bay.	Brown filly.	Mirza.	Vol. 41, p. 282.

TABLE VII.

Breeding Record of Melissa (46,573).

Year.	Sire.	Colour of Sire.	Progeny.	Name.	Stud Book Reference.
1918	Dunure Luxury (19,105) .	Bay.	Brown filly.	Meena.	Vol. 41, p. 769.
1920	Drumcross Radiant (18,323)	Brown.	Brown filly.	Melinda.	Vol. 43, p. 275.
1921	Royal Success (20,175) ...	Bay.	Brown filly.	Malva.	Vol. 44, p. 238.

Tables VI. and VII. give the records of two browns, but many more have been tested to the second and third generation and all have bred true to colour. In no case has a grey appeared except from a grey parent.

Illustrations 3 and 4 show the first generation of browns from the light grey. Contrary to existing belief among breeders, there would appear to be no connection between grey and roan, and these must be distinct colours. In this connection it may be noted that many of the horses used had white hairs through the coat, but the progeny from such were invariably of sound colouring.

The distinctive feature of the foregoing records is the striking way in which the colours have segregated out, and the whole experiment suggests that sound colours are inherent and indestructible and can be retained by careful mating and selection.

THE BIOLOGIST ON THE FARM.—No. XVI.

Professor J. ARTHUR THOMSON, M.A., LL.D.,

University of Aberdeen.

The Origin of the Collie.—How many difficult problems stare us in the face! That never-too-much-to-be-admired collie, where did it come from? From a wolf, the zoologist says, but what wolf and where? After a year's study, including hard work over many

skulls, one might perhaps begin to have a right to an opinion; but the probabilities are that we should offer none. For those who know most about these intricate questions are usually least willing to give an answer. For the pedigree is lost in prehistoric times, and its decipherment is dubious and unverifiable.

But while there is a great deal to be said for well-informed agnosticism, we must say something when a student asks us where the collie came from. The tentative answer we shall give at present is somewhat as follows. In prehistoric times there were several kinds of domesticated dogs in Europe, and one of these is called by a rather beautiful name—"the best-mothered dog," *Canis matris optimæ*. Its remains are found in Bronze Age stations, and it is almost certainly the ancestor of the more old-fashioned sheep-dogs, like the Belgian, and, in more recent times, probably after some crossing, of highly evolved "sheep-dogs" like the Alsatian and the collie. But this "best-mothered" domestic dog can be traced back to a still older domesticated dog of the Stone Age, which bears considerable resemblance to the dingo of Australia and to the pariah dogs of Africa and the East. This scientifically famous dog is called *Canis putiatini*, and it is the oldest known European domestic dog. It may be conveniently called after its discoverer, the late Professor Theodore Studer of Bern, Studer's dog or the Stone Age dingo-like dog. It was probably ancestral not only to the "best-mothered" dog (*Canis matris optimæ*), whence came sheep-dogs; but to the "peat-dog" (*Canis palustris*), whence came Scotch terriers, for instance; and to the "intermediate dog" (*Canis intermedius*), whence came fox-hounds, for instance. Thus the question becomes: what was the origin of Studer's Stone Age dingo-like dog? The probable answer is: a small-sized southern wolf, which it is probably wisest not to try to name. In some cases, apart from the original derivation from a southern wolf, there was in all likelihood subsequent crossing with a northern wolf, and it is this probable crossing and re-crossing, indicated by admixture of characters, that makes deciphering of pedigrees so difficult. Thus in the greyhounds, which probably arose to the south of the Mediterranean from pariah-like ancestors, there may have been an admixture of the blood of a gray jackal or of a jackal wolf; and later on, as peoples moved, a crossing with North European dogs with wolf's blood in them. This is just an instance of the complications that may have arisen. It seems very unlikely that the common jackal (*Canis aureus*) ever gave rise to a domestic dog.

Long before the European discovery of America there were various kinds of domestic dogs well-established there, such as the sheep-dogs, dachshunds and bulldogs of the Inca civilisation. It is possible that some of the North American domesticated dogs arose independently from a wolf species or from the coyote; but there is considerable reason for supposing that explorers from the Polar regions migrated southwards into America, bringing with them dogs which had originated in the Old World. To return to our question: Whence came the collie; we should at present answer, following Studer, Antonius and other authorities, that it is a highly evolved descendant of the "best-mothered" domestic dog,

which arose from Studer's Stone Age dingo-like dog. If one traces further back, one lands on a small-sized southern wolf, which lived perhaps in Spain.

The Renaissance of the Turkey.—At this season of the year our thoughts run to turkey, and we cannot but be grateful to the far-seeing members of the American wild-turkey species that allowed themselves to be brought to Britain and Europe about 1530. We say *far-seeing*, for the bird's acquiescence led not only to an abundant supply of very excellent food for festive occasions, but it preserved from probable extinction the largest of game-birds and a very interesting individuality. As everyone knows who cares to know, our domesticated turkey (called turkey because it says that this is its name) had its origin in the North American wild turkey, *Meleagris gallopavo*, which was once incredibly common in the United States. It condescended to live under man's ægis without surrendering almost any of its native good qualities. Thus it did not make a *sine qua non* of roosting in trees, as is its habit in the wild state; in fact it protests against little, unless (among the turkey-hens) against being made into an incubating machine for fowls' eggs. What happened in the United States was what has happened too often in man's history —a greedy, ruthless and short-sighted persecution of a fine living creature. The wild turkey suffered for its palatability and also for its large size—an easy target. The extreme wariness of the present-day remnant is said to be a recent evolution. Till lately, the wild turkey in the United States was being hastened to extermination. But what we are delighted to record is that in the last few years there has been a striking improvement. In some mountainous regions in Pennsylvania, for instance, large flocks have been recently seen just as in old days, and they are no longer being shot down. It is true that some farmers are complaining that their domesticated turkeys fly off to consort with long-lost wild relatives; but it should not be beyond the wit of man to regularise this, and to secure, if desirable, some measure of reciprocity. An occasional dash of wild blood might be in the case of turkeys—so slightly altered by domestication—no bad thing. But what we are concerned with is recording a welcome renaissance of the wild turkey in the United States. Long may it last!

Rat Poisoning.—An acute correspondent calls our attention to the fact that when rats devour the dead bodies of their neighbours that have been poisoned with strychnine they are sometimes quite unaffected. Why should this be? We put the problem to Professor C. R. Marshall, who was kind enough to give the following explanation. In all probability the second rat does not receive a lethal doze by eating the flesh of the first. Even if it ate the whole of the poisoned rat without help from others, there would be delay in absorption and consequently less effect. This is the probable solution of the difficulty. Strychnine is not known to be changed by the tissues after absorption, so the explanation cannot be along this line. When a rat devours a neighbour that has been killed with "virus" the meal is fatal, and that is because a true "virus" is a concoction of microbes which multiply pro-

digiously. In view of the laws about the use of poisons and the danger of some useful creature eating what was meant for rats, the safest bait is a paste of red squill powder, fine oatmeal and dripping, in the proportion of 2, 5, 3 parts by weight, the dry ingredients to be mixed up with the melted dripping so as to form a thick paste. Chloride of zinc is an effective deodoriser when the poisoned rat's body cannot be recovered without trouble. See Leaflet 244 on The Destruction of Rats issued by the Ministry of Agriculture and Fisheries.

Rats and Amœbæ.—The arraignment of an animal like the fox leaves scope for discussion, but no one has any theoretical hesitation in regard to rats. Is it not the case that every man in Great Britain and Ireland has not only his shadow but his rat—which is also a shadow. There is no need to speak of its prolific multiplication, its voracity, its wastefulness in spoiling stored food, its destructiveness to wood-work, the toll it takes from poultry and the like, and its connection with such diseases as Trichinosis and Plague. Everyone is convinced that the rat is a serious menace, and yet, in spite of all that is being done, it cannot be said that man is putting sufficient energy into the contemptible campaign. We wish to refer for a moment to a new charge against rats and mice, that they are carriers of amœbæ, which cause intestinal disease in man. John F. Kessel has shown (*University of California Publications in Zoology*, vol. xx., October 1923) that rats and mice can be infected with five of the amœbæ found in the intestine of man, including the amœba of dysentery. The amœbæ transferred from man to rodent underwent no racial change during the period of the experiment. Though infections with Endamœba dysenteriæ apparently assume a chronic rather than an acute form in rats and mice, four of the rats died, one of them showing intestinal ulcer. "Heavy suspicion is thrown on the rat and mouse as possible carriers of the causative organisms of human amœbiasis."

Bacteria and Butyl Alcohol.—One of Professor Edwin E. Slosson's stories in his admirable *Keeping up with Science* (Cape, London, 1924), has to do with Bacteria and Indian Corn. When the foreign supply of acetone, a substance of well-known importance in making cordite explosives, was cut off during the war, the fortunate discovery was made that a certain kind of Bacterium could produce acetone out of the starch of Indian corn, just as yeast produces alcohol. In a short time acetone was being turned out in large quantities in distilleries in Toronto and Terre Haute. But after the war the market for acetone slumped and the distillers were in a quandary. As has happened so often, however, a way out has been found by utilising a by-product called butyl alcohol. This is similar to the "fusel oil" which is much used as a solvent in the manufacture of varnishes and lacquers. But "fusel oil" is a mixture and variable, whereas butyl alcohol is a pure substance with definite properties. Therefore it can be used in various industrial processes for which fusel oil is less suitable or not suitable at all. Thus it has come about that Bacteria are now being used to turn a million of bushels of Indian corn every year into butyl alcohol.

Must the European Bison perish?—Some years ago it became evident that the American bison (*Bison americanus*), once so common, was dwindling with ominous rapidity. In spite of protection, the numbers of the remnant herds were reduced in 1889 to about a thousand. It was then that Dr. William T. Hornaday, the present Director of the New York Zoological Gardens in the Bronx Park, threw his energy and scientific skill into an endeavour to rescue the bison from extinction. He started a Bison Protection Society and educated public opinion, and he has had a great reward. Last year the number of American bisons was estimated at over eight thousand.

But it is far otherwise with the European Bison or Wisent (*Bison bonasus*), which once roamed over Europe, including Britain. The cutting down of the forests, the spread of agriculture, and man's ruthless greed were the main causes of the gradual restriction of its range and the great reduction of its numbers. At the beginning of the twentieth century there were but two places where herds of bisons still survived in wild conditions. One of these was the Bialowieza Forest in Lithuania, and the number was estimated at about seven hundred. About the same number inhabited mountainous forests in Circassia. In both areas the preserving was extremely strict and the punishments very severe. But just as the Napoleonic war at the beginning of the nineteenth century involved a reduction of the Bialowieza bisons to 300,—a number subsequently more than doubled, so has it been with the Great War. In 1918 there were only 200 left, and in the aftermath these have all disappeared. The same dismal story is true of the Circassian herds, which the Bolshevists finished off with mitrailleuses. This is matter for great regret, for the bison is a noble animal, an antiquity, scientificially very interesting and practically very useful. Its flesh is palatable and its hide is thick The solitary bulls were sometimes troublesome, but there is very little to be brought against the bison, except that it barks some of the forest-trees in hard winters. What is to be done? There are still between thirty and seventy individuals in various European parks, including nine at Woburn Abbey; and the somewhat forlorn hope is that from this remnant it may be still possible to reinstate this splendid creature. It is past the eleventh hour, but the Bison Preservation endeavour that has been started at Warsaw and elsewhere must have the best wishes of all men of good-will.

Lactation and Gestation.—There is an interesting point in regard to the European bison's family affairs, but there is an unfortunate lack of unanimity among the naturalists who have described what happens, and unless a renaissance occurs there will be no opportunity for further enquiry. The bison is said to be a long-lived animal in wild conditions, the bulls reaching fifty years, the cows thirty or forty. It is not surprising therefore that the cow-bison should not be fertile before she is five or six years old. The herds, usually numbering 7-20 individuals, consist of cows and young males, for the old bulls live alone except at the pairing season in September. The cow carries her calf for nine months, so that the time of birth is about June. But it is said that the

cow never has another calf until at least two years have passed. One reason for this is that she takes her calf apart and has a prolonged period of lactation, lasting for a year or more. During the first year at least the cow-bison does not share in the life of the herd. It must be admitted that accounts differ, but it is interesting to note Dr. Hornaday's statement that the calf of the American bison is suckled for at least a year. The two species are closely related.

Uses for Weeds.—We ought to have in this country a body of well-paid experts set apart to discover uses for the useless. Thus it would pay the country to give a considerable number a thousand a year to find out a remunerative use for bracken. When they had solved that problem, they could go on to another. Take, for instance, the Jimson Weed in the United States. It was till lately just a poisonous weed, belonging to the deadly nightshade or potato order. But it has been found to contain some *atropin*, which is of much service in the examination of the eyes. The supply of atropin has hitherto come for the most part from Atropa belladonna, the deadly nightshade, but the drug has been somewhat scarce and somewhat dear. Now the modern herbalists have tapped the Jimson Weed, and "a liability has become an asset."

LEAF ROLL, MOSAIC, AND RELATED DISEASES OF THE POTATO.[1]

PART I.

IT is only within very recent times that a successful attempt has been made to study the aggregate of diseases known in this country from the beginning of the eighteenth century as curl of the potato, the detrimental effects of which were realised but not understood.

The first step in the solution of the problem was the segregation, in Germany, in 1905, of the form of disease known as leaf roll. The study of leaf roll has been further developed, particularly by H. M. Quanjer and Oortwijn Botjies in Holland, Schultz and Folsom in the United States of America, and Murphy in Canada and Ireland. Mosaic was the next disease to be separated out from the aggregate. This particular type was noticed by Orton in Germany in 1911 and described by him in 1914. Quanjer claims to have noted the disease in 1908 and to have described it in 1913. In 1920 Murphy published a description of a third type which he named crinkle. To the inexperienced observer crinkle somewhat closely resembles mosaic. For this reason the name is not yet in general use in this country, and all plants affected with crinkle have been simply referred to as having mosaic or occasionally curly dwarf. Streak, first so named by Orton in 1913, is the fourth member of the group. This disease was fully described by Atanasoff in 1923 under the name of stipple-streak.

[1] Bibliography will be appended to the second part of this article, which will appear in the April number of the JOURNAL.

Typical leaf-drop in an unknown variety. The secondary form of stipple streak.

Early stage of streak showing the spots on the leaflets and the discolouration in the leaf stalk.

Typical crinkle in an unknown variety.

Reprinted from Bulletin No 44, Investigation of Potato Dis
issued by Canadian Department of Agriculture.

LEAF-ROLL DISEASE.

A typically diseased plant of Up to-Date.

Reprinted from the Journal of the Department of Agriculture and
Technical Instruction for Ireland, Vol. xvii, No. 3.

MOSAIC DISEASE.

A diseased plant (left) and a healthy plant (right) of Irish Chieftain.

These are the four chief "constituents" of the potato growers' curl, although there are other minor forms to be considered, and mosaic itself is now believed to comprise several distinct forms of disease.

The knowledge of the nature of these diseases spread slowly, and their significance would have been little recognised in this country but for the attention devoted to the potato in connection with efforts to control wart disease. Official action in this direction resulted in the appearance of many new varieties on the market, and the tendency of many of these varieties to deteriorate under the influence of "cure" served to concentrate interest on the study of these degenerate effects.

Cause of the Diseases.—The possibility that some of the diseases may arise spontaneously as the result of toxic products being formed by functional disorders is discredited by all prominent workers on the subject. As an infective principle is known to be present in the sap of all diseased plants, and as all attempts to discover causal organisms have failed, each of the diseases, except perhaps stipple streak, is now ascribed to a virus. A virus is of such a nature that it cannot be seen even with the aid of the most powerful microscope, and it will pass through very fine filters, thus differing from bacteria, which can be seen by means of a microscope and can be retained by fine filters. For convenience the cause of each of the diseases will be referred to as a virus, and the diseases themselves as virus diseases. The carriers of the virus in the field are greenfly (*Aphids*) and other sucking insects.

There is a belief that the diseases are the direct result of continuous vegetative propagation over a long period, but this idea is fallacious. Stocks of some very old varieties such as Rocks (identified by Murphy with the "Yellow Potato" mentioned by Arthur Young in 1776), Lumpers, Black Bull, Yam, Apple (all mentioned in Lawson's List of 1834), Shetland Black, Old Long Blue and Home Reds (all over 80 years old) have been received at East Craigs from isolated districts in Ireland and the north of Scotland in a healthy condition, and have all contracted severe forms of disease before the end of the second year. On the other hand, seedlings may readily contract the diseases even in the first year of their existence. Another view is that the diseases are caused by cultural and climatic conditions. There is more reason in this view, because there is no doubt that these conditions affect the degree of incidence of many of these diseases considerably.

Description of the Principal Types.

The symptoms of the virus diseases vary according to locality, climatic conditions, variety, time of year, age of plant and degree of infection, *and it should be noted that a plant is sometimes affected by more than one of these diseases.* The following notes indicate the main distinguishing features of each.

Leaf Roll.—There are two stages of the disease, primary and secondary. The appearance of affected plants in the secondary stage is very typical. The tips and margins of the lower leaflets

are rolled upwards and inwards on the midribs into the shape of a spoon, and later almost into the shape of a funnel. All the leaves except the lower ones may be normal, and frequently not even all the latter are involved. In other cases, the upper leaflets may show considerable rolling, particularly as the season advances. *The thickening and rolling of the lowest leaflets are constant throughout the season, and constitute the one invariable external symptom of the disease.* The rolled leaflets are distinctly harsh, brittle and crisp, and feel leathery owing to their being thicker than is normal. As the disease progresses, the tips of the rolled leaflets become yellow, and later brown, while red or purple areas may develop on the lower, and also sometimes on the upper, leaflets. The exposed lower surfaces of the rolled leaflets frequently present a silvery or purplish appearance. In many cases the leaves become more or less erect, and the whole plant is generally reduced in vigour and height. On account of the abnormal rigidity and partial drying out, a rattling sound may be produced when a rolled leaflet is brushed with the hand. "Secondary leaf roll results from the planting of an infected tuber, and is the commoner form of the disease. When a previously healthy plant becomes infected in the field from a neighbouring diseased plant there may be no visible sign of infection until the following season, when the tubers give rise to plants showing secondary leaf roll.[1] In many cases, however, the disease becomes evident during the season in which infection takes place, as a stiff upward rolling of the topmost leaves and then progressively of the lower ones. This phase is known as 'primary leaf roll.' Plants affected with primary leaf roll, as a rule, suffer little or no reduction in yield, but the plants resulting from their tubers show the secondary form of the disease in the following season" (*Murphy*). Leaf roll does not cause a premature ripening except in the most extreme cases. A constant feature of true leaf roll is the death of the food-conducting tissue which follows the accumulation of starch in the leaflets. In healthy plants the starch manufactured in the leaf is changed into sugar and transported to the tuber during the night; in the early morning there is no starch on the leaf. Diagnosis of leaf roll can, therefore, be confirmed by the presence of starch in the leaf in the early morning, which can be detected by means of an iodine test. Abnormal starch accumulation has been found to be a constant symptom of the disease in a large number of varieties, and no example of leaf roll has been found without it.

American observers state that the tubers of plants affected with leaf roll frequently show net necrosis — the presence of fine net-like strands of dead tissue in the outer part of the flesh of the tuber—associated with a spindling condition of the sprouts, but these features have not been found in Scotland to be symptomatic of leaf roll. "Except in severe forms of leaf roll the tubers are unaffected, but in extreme cases (probably due to the presence of other diseases) certain appearances of the flesh are characteristic, namely, a dirty yellow colour; a granular and rather water-soaked appearance of the cut surface, which

[1] "Some of the tubers produced in the season in which infection first takes place may escape the disease and produce healthy plants."

soon becomes slimy as though covered with bacterial growth; the development of a peculiar brown red colour some time after cutting; and the presence in many cases of necrosis in the neighbourhood of the vascular ring" (*Murphy*). Badly affected tubers generally sprout slowly. In the case of severely affected plants the tubers are small in the run and are borne on short stolons close to the stem. It will generally be found on lifting an affected plant that the old sett has not decayed. This is not an invariable rule, and is not confined to leaf roll alone. Once a plant is affected with the secondary form of the disease, its progeny never recovers. On the other hand, in the absence of infection with other diseases, there is no progressive degeneration, the affected stock fluctuating about the same level every year.

Careful observation is necessary to distinguish the symptoms of true leaf roll from the leaf roll symptoms of Rhizoctonia, Blackleg and Verticillum Wilt, from those due to animal and mechanical injuries to the stems, and from those caused by unfavourable growth conditions such as excessive wetness or dryness of the soil. Frequently seedlings are noticed which show a limp rolling on the upper leaflets, due to injury to weak stems by strong winds. The chief difference between the symptoms of true leaf roll and those of any of the above conditions is that in the latter the leaflets are flaccid and limp and not leathery and crisp.

The rolling of the leaflets on the lower leaves does not usually take place until several weeks after the plants have come up. Occasionally, however, the disease is evident as soon as the leaves appear, although at East Craigs it is always about the middle of July before the symptoms are evident. The diseased appearance is assumed with considerable suddenness. There is no starch accumulation nor phlœm necrosis until the rolling takes place.

No varieties are known which are immune. Some, however, appear to contract infection or to display symptoms less readily than others. Reports obtained from twenty-five pairs of inspectors for a period of three years indicate that in Scotland the least affected varieties are Templar and Great Scot. The varieties most generally affected are Kerr's Pink and British Queen; next in order are Katie Glover and Lochar, while less seriously affected are Duke of York, Majestic, King George V. and King Edward VII. Great Scot and Crusader are also slightly affected. These reports do not indicate the natural resistance or susceptibility of the varieties, but merely the condition of the stocks in Scotland. Murphy classes varieties in the following order, as the result of experiments carried out near Dublin :—

Most resistant.—Shamrock group.

Rather susceptible.—Ally, Arran Comrade, Dominion, Epicure, Irish Chieftain, Majestic, Snowdrop, Sharpe's Express, Flourball, Tinwald Perfection.

Very susceptible.—Abundance, Arran Rose, British Queen, Duke of York, Sir John Llewelyn (Eclipse), Edzell Blue, Great Scot, Irish Queen, Kerr's Pink, King Edward VII., May Queen, Peerless, President, Summit, Templar, Up-to-date.

Leaf roll appears to a great extent in some stocks in Scotland, but it is not nearly so prevalent as mosaic, which, in Scottish conditions, appears to be the more infectious disease. Seedlings are much less frequently affected with it than with mosaic. On account of these facts and because it assumes only one form, leaf roll is not nearly such a troublesome enemy to potato growing in Scotland as is mosaic.

Mosaic.—The symptoms of mosaic vary considerably according to locality, climatic and cultural conditions, variety, time of year, age of plant and recency and intensity of infection, but the following description indicates the main distinguishing features.

The individual leaflets, instead of presenting a normal uniformly green appearance, are faintly mottled or spotted in various shades of pale green. In mild cases mottling of the foliage is the only sign of the disease, but, as a general rule, the leaflets are also crinkled or puckered to a greater or less extent and their margins become wavy. In some varieties, for example, Majestic and King Edward, the crinkling and puckering is not marked. In the former variety mosaic has the effect of giving the leaf a yellowish green appearance. In severe cases the leaflets become distorted and more or less reduced in area, and the foliage may become spotted with brown flecks of dead tissue; in extreme cases the whole plant is dwarfed and the foliage is small, contracted, crowded and curled like that of a dwarf plant of green kale; the characteristic mottling is, however, evident. In yield trials of varieties at East Craigs it has been found that severely affected plants are of much earlier maturity than normal plants, and produce little or no crop. This observation confirms others made elsewhere. It has been noted at East Craigs and elsewhere that plants severely affected with mosaic have their capacity for flowering markedly reduced.

The one constant feature of mosaic is that there is a reduction in chlorophyll—the green colouring matter in the leaves—which is necessary for starch formation. The exact correlation between the amount of chlorophyll and the amount of starch formed has not been worked out. It is possible, especially under certain conditions, that there is an excess of chlorophyll, and that the plant can stand a certain reduction in its amount.

The conspicuous yellow spotting sometimes seen on potato foliage is distinct from mosaic, and from its resemblance to that of *Aucuba japonica* it has been called Aucuba disease.

"The mottling of mosaic disease is materially modified by climatic conditions and by the age of the plant. In cooler and damper regions typically mottled foliage may be found throughout the whole season, but in the hotter and drier parts of the country this feature, though quite evident earlier in the season, may become much less marked and may even disappear. The crinkling of the foliage, however, remains. The mottled effect is more clearly discerned on a dull day, or when an affected leaf is held in the shade. A white sheet of paper held under the leaf also assists in throwing the mottling into relief."—(*Ministry of Agriculture and Fisheries.*)

Under Scottish conditions the progeny of plants previously

infected with mosaic usually show the mottling symptoms as soon as they are through the ground or shortly afterwards. In the case of the progeny of plants only lately infected in the previous season the mottling symptoms may not develop in the early part of the season. The mottling symptoms frequently disappear when the plants are maturing, especially if the mottling is slight.

The diagnosis of mosaic is, therefore, frequently very difficult. In the medium and severe cases of mosaic, wrinkling and waviness of the margins is diagnostic for most varieties, but, as wrinkling is natural for many varieties, the further symptoms, such as mottling, dwarfing or waviness of the margins, are necessary for confirmation of the presence of the disease. If rogueing is to be attempted, the importance of doing so throughout the season from the earliest opportunity is obvious.

It has been stated that mosaic starts generally as mild mottlings, and that the later developments are wrinkling and ruffling and, finally, dwarfing of the whole plant. It is, however, the opinion of many workers on the subject (including Murphy), that the different grades of mosaic are separate diseases, and that the appearance of wrinkling and dwarfing following mild mottling is due to infection with these grades of the disease. This means that, in the absence of infection by the other grades, mild mottling always remains mild mottling, and that it should be possible to produce the symptoms of any one grade outright without the appearance of the milder grades by infection with that particular grade. This theory, although widely held, has not been proved. *It would be an advance in knowledge of the greatest importance if it were known whether or not mild mottling indicates greater susceptibility to severe mosaic either in the individual plant or in the variety.*

A further complication arises from the fact that mosaic symptoms vary under different localities and cultural conditions. Thus, it has been found in the United States and in Canada that, if a tuber from a plant with mild mosaic is split into four and the four portions sent to widely different districts, the appearance of the plants at the four centres is not identical. There may be a marked increase in the severity of the symptoms, which would be ascribed by some workers to new infections. On the other hand there may be a suppression of the symptoms. In this case, however, the disease is still latent, as can be proved by grafting part of the plant on to a more susceptible variety or by returning the stock to its original home, when under controlled conditions the symptoms will again manifest themselves.

In common with all the other virus diseases the tuber progeny of a mosaic plant all carry mosaic. There is an exception, however, in the case of plants infected late in the season. Some of the tubers or some of the eyes may escape infection and give rise to healthy plants. The following statement referring to the progeny of newly infected plants from Schultz and Folsom is interesting. "It has been reported that a small proportion of tuber units may contain both healthy and mosaic hills, and that in such mixed tuber units the diseased hills (plants) are at first about evenly distributed between bud-end hills and stem-end hills, but later are more common in the bud-end hills. The difference thus shown at first

between sister hills in regard to mosaic is apparently due either to unequal retardation of the appearance of symptoms or to unequal distribution of the virus in the tuber. The later development of the difference between bud-end and stem-end hills may be due, as far as is known, to the greater number of eyes in the bud-end quarters and the resulting better chance to include a diseased eye, or to field infection that affects the faster growing bud-end plants more and that produce symptoms apparent the same season." It thus seems to be possible to raise healthy stock from a seedling infected with mosaic provided the tubers are lifted soon after the time of infection.

It will be a serious matter if it is true, as a recent American worker (Elmer) states, that mosaic of potato can be transferred to totally unrelated plants such as clover, cucumber and others. This finding awaits confirmation. On the negative side of the question Schultz and Folsom have endeavoured to infect potatoes with mosaic from wild raspberry bushes. The ordinary methods of infection failed to transmit the disease from the raspberry to the potato. It is possible that greenfly might be successful in transmitting mosaic from the one to the other, but in north-eastern Maine, where these observations were made, no greenfly were found to infest both raspberry and potato. "While it is true that there may be certain specific mosaic diseases, such as that of *Nicotiana viscosum*, it is also true that, in general, the same disease is communicable, if sometimes with difficulty, to tobacco, tomato, potato and to various wild and cultivated plants belonging to such solanaceous genera as *Solanum*, *Physalis*, *Capsicum*, *Datura* and *Nicotiana*. It has, indeed, been found in America that some perennial weeds belonging to the genera *Physalis* and *Solanum* carry infection over the winter in the case of tomato mosaic, and that they are one of the principal sources of infection for the tomato crop in the following season" (*Murphy*). Solaneous weeds in this country do not occur commonly, so that there is little danger from them.

In cases of severe infection the seed tuber does not generally rot in the soil, but remains hard. It is impossible to tell from the tubers whether or not they are carrying mosaic infection, and no correlation exists between mosaic infection and colour of sprouts. Tubers from severely affected plants sprout more slowly than normal or mildly affected tubers.

Mosaic is widespread in all districts of Scotland. Its effects on yield, like the symptoms, however, vary considerably according to climatic and cultural conditions, intensity of infection, soil and variety. The remarks which appear above on susceptibility of varieties to the effects of leaf roll apply equally to varietal response to the effects of mosaic. Statistical information derived from reports by the Board's inspectors on the prevalence of mosaic in Scotland shows that the variety least affected is Great Scot; next in order of resistance are Epicure and Sharpe's Express, while Up-to-Date, Early Market, King Edward VII. and Arran Comrade are fairly resistant. In the susceptible group the varieties most frequently and most severely affected are the Langworthy types (including Golden Wonder), Arran Chief

and Tinwald Perfection; Majestic, Lochar, Kerr's Pink and Rhoderick Dhu form a group which is affected to a less extent. The following varieties, of which only small acreages were planted, are severely affected:—Irish Chieftain, Buchan Beauty, Katie Glover and Immune Ashleaf. In Katie Glover and Arran Chief marginal leaf rolling mosaic is included as mosaic.

Crinkle.—This disease appears to be the same as the rugose mosaic of Schultz and Folsom in the United States of America. Crinkle somewhat resembles mosaic, and probably much of what is termed mosaic is really crinkle. Crinkle, however, is differentiated from mosaic by more diffuse mottling, and more pronounced puckering and wrinkling in which the depressions are chiefly along the veins. *The most marked symptom of all is that the margins and especially the tips of the leaflets are curled downwards.* The leaflets are very diffusely mottled and the veins on the lower sides frequently show dry brown streaks, while a similar discoloration may develop in minute isolated spots on the leaf blades, giving the leaf a finely spotted appearance. The lower leaves drop prematurely, and the plant withers and dries up before its time. The plant is notably dwarfed, bronzed and chlorotic (*i.e.* with diffuse pale yellow areas on the leaves), and the tissues are brittle. It appears that streaking may occur on the stem in this disease, but this is a feature which requires further study. The plant in advanced stages is unable to exhaust the seed tuber. Crinkle has been shown to be more infectious than mosaic and leaf roll. The disease materially reduces the vigour and yield of the plant, and, unlike other diseases, it is not influenced in its development by the nature of the season.

No information regarding the amount of crinkle in Scotland or on the susceptibility or resistance of varieties in Scotland is available, but it was identified on a number of plants at East Craigs in 1924. There is reason for suspecting that many of the dwarfed rusty plants in crops in the South are examples of the effects of crinkle. Although crinkle resembles mosaic it is quite distinct from it; in the absence of further infection mosaic never develops into crinkle, and similarly crinkle never loses its distinctive features to become mosaic.

It is important to distinguish plants affected with crinkle from plants suffering from potash hunger. In the latter case the leaflets show brown spotting and the downward curling of their margins, but they are not corrugated.

Streak.—There is probably more than one form of streak. The form described by Orton and later by Atanasoff has been called by the latter stipple streak. The symptoms vary with variety and other conditions. Affected plants are at first of normal size and appearance. The primary symptoms take the form of angular dark brown or black spots on the leaf blade (larger than the spots found in crinkle) which join the veins and run down through the latter into the leaf stalk and stem in the form of a deep seated dark streak. The spots are of the same size and form on both sides of the leaves. The streaks in external view are not continuous over the whole stem and may be seen more or less on all sides of the stem, though in some cases they

are limited at first to one side. Once the leaf stalk is invaded the leaf rapidly dies. Affected leaflets become brown and shrivelled, the original spots showing up clearly, while the unaffected leaflets become pale green and then yellow. The dead leaf remains hanging to the plant, which dies prematurely. There is complete disorganisation and breaking down of the tissues of the leaf stalks. Temperature has a marked influence on the appearance and further development of stipple streak. It has been found in Holland that a low temperature considerably retards the progress of the disease.

The tubers of primarily affected plants develop curious brown blisters around the eyes. In some varieties these blisters crack. Rusty specks on the outer part of the flesh may also be present in some varieties. The eyes do not always develop sprouts.

The secondary symptoms appear in the following year. The plants are extremely dwarfed, with brittle brown-stained stems, and small downward curling puckered leaves, the lowest of which drop off. *Eventually all the leaves except those at the top drop off, giving the plant the appearance of a miniature palm tree.*

Secondarily affected plants are very seldom able to exhaust their seed tubers, which remain hard and watery. The tubers from secondarily affected plants are very small, and are usually incapable of development. The disease is therefore very rapidly self-exterminating. Its rapid and fatal progress suggests the action of a bacterium rather than that of a virus, but there is no proof of this.

Although Atanasoff considers that stipple streak was at times epidemic in this country in the 18th and 19th centuries, there is no definite record of the occurrence of stipple streak in Scotland at the present time.

Transmission has only been demonstrated in the case of transfer by leaf inoculations of juice from affected plants to healthy plants. It has also been further established that aphids when fed on sprouted diseased tubers for several days, then transferred to healthy sprouted tubers, will transmit the disease to the latter; the disease becomes visible on the healthy tubers within one month, if these are kept at a normal temperature. Such tubers upon planting give rise in all cases to secondary stipple-streak plants. Transmission by aphids in the field has not so far been demonstrated. Murphy did not notice any natural spread. If such transmission does not take place, or is unusual then the non-occurrence of plants affected with stipple streak is only explained in view of the self-exterminating nature of the disease.

The full description of the disease is given here b[illegible] in Holland it assumes serious proportions and many crops have been affected. The spread of the disease is at present limited, but it is considered "that under certain conditions an[illegible]er-tain years it may become of very great economic im[illegible]e" (*Atanasoff*). The advisability of excluding Dutch see[illegible]es from this country is indicated. According to Q an[illegible]re seem to be several forms of leaf-drop streak in Holland.

While there is no evidence of the existence of stip[illegible]ak in Scotland, a form of streak is common on seedlings, p[illegible]ly

those of Majestic parentage. Affected plants have the symptoms of primarily affected plants of stipple streak, but the spots on the leaflets are not joined to the veins and there is no leaf-dropping. There are no marks on the tubers, and the streaks on the stem are confined to the wings. All the leaves on the plant generally become affected. At East Craigs the symptoms do not usually appear until about the end of July. The spots and streaks do not seem to be markedly detrimental to the plant, although it is obvious that the area of leaf surface for carbon assimilation is greatly reduced. Nevertheless very good yields have been obtained from such affected plants. In the second and subsequent years the symptoms of the disease are similar and do not become worse, at any rate under the conditions where this disease has been noted. At Philpstoun, however, it was noticed that stocks showing the disease there for the third year were adversely affected. The spots on the leaves increased greatly in number, the leaves dried up prematurely, and the yield was consequently much reduced. This disease has been confined to particular seedlings and has not been observed to spread to other varieties grown in close proximity.

Other Degenerative Diseases.

The diseases described below have been little studied, and information regarding them is very incomplete.

Marginal Leaf Rolling Mosaic.—This differs from true leaf roll in that there is no phlœm necrosis and only the margins curl upwards. The upturned margins are markedly chlorotic, and mottling is present on the remainder of the leaflet. Crinkling occurs on the variety Arran Chief. Among British varieties the disease has only been noted on three, namely, Arran Chief, Katie Glover and Catriona, *but it is of widespread occurrence in stocks of the two former.* In Arran Chief and Catriona, the symptoms differ from those of ordinary mosaic in the same varieties in respect that plants of Arran Chief and Catriona with ordinary mosaic do not show the upward curling of the margins of the leaflets. In Katie Glover ordinary leaf roll and ordinary mosaic have been observed. The symptoms of each are quite different from the symptoms of marginal leaf roll on the same variety. All the leaves on the plant may be affected and the effect on the yield is very serious. The disease is transmitted through the tubers, but it has not been noted to spread to other varieties grown in close proximity. No information is available regarding transmission by insects or otherwise, or regarding varietal immunity. The marginal leaf rolling mosaic here described does not appear to be identical either with marginal leaf roll (*Quanjer*) for which no mosaic symptoms were noted, or with leaf rolling mosaic (*Schultz* and *Folsom*) in which the leaflets are figured as rolling on their midribs.

Aucuba Mosaic.—The only symptoms of this disease consist of bright yellow patches, more or less round, on the leaflets. The spotting resembles that of the leaf of Aucuba japonica, hence the name. This trouble is found mostly in early varieties. It is very common in Ninetyfold, but has also been found in Epicure, Fiftyfold,

Duke of York, British Queen, King George V., Catriona, Majestic, General and President. This disease is transmissible through the tubers and by grafts, but insect transmission has not been reported. No natural spread has been noticed in Scotland. Aucuba generally occurs only as a few spots on each plant and therefore the effect on the yield is negligible.

Marginal Variegation.—This condition is indicated by a narrow band extending right round the margin of the leaflet, which lacks chlorophyll and is therefore of a lighter green colour. There are no other symptoms. All the leaflets on a plant may be affected and the effect on the yield may be appreciable. The disease may be regarded as a localised chlorosis. It is perpetuated through the tubers, but transmission by graft, leaf inoculations or insects has not been demonstrated. Specimens of the variety King Edward VII. affected with marginal variegation have been collected at East Craigs.

Another form of severe chlorosis in this variety has been noted. The leaves of affected plants are a very pale yellow in colour. The condition is perpetuated by the seed tubers.

Curly Dwarf.—The symptoms consist of a very pronounced dwarfing and wrinkling of the foliage, the whole plant being much reduced in size and resembling green kale. Mottling may also be present.[1] The stem is brittle and the tubers are very small. In Scotland it is probable that curly dwarf is a complex of diseases embracing a severe grade of mosaic and possibly crinkle and some leaf roll. Its presence is frequent, but affected plants are generally regarded as examples of the effect of severe mosaic. A stock of an Ally bolter has been under observation at East Craigs for three years. The plants were originally affected with mosaic, but each succeeding year curly dwarf symptoms have become more severe until now the stock is exterminated.

Intercostal Necrosis.—This form of disease was first observed by Mackelvie on seedlings at Lamlash. The tissue between the veins becomes brown and dead, all the tissue being affected except for a narrow band on each side of the veins. All the leaflets may be affected, and the disease may appear all over the plant. It seems that the brown necrotic appearance is the first evident sign of the disease; at any rate no earlier symptoms have been noted. The disease appears in the middle of the growing season and the result is that the plants die weeks before their time. Information regarding transmission or perpetuation is not available. Similar symptoms appeared extensively on the Great Scot plots at East Craigs at the end of the season of 1924 In this case the browning did not appear to be doing any damage. On the contrary it might be taken as a normal appearance of Great Scot when it is dying down. Quanjer has described a disease which he names interveinal mosaic, the symptoms of which do not correspond with those of intercostal necrosis.

Rust.—This is characterised by a rusty appearance of the leaves and premature withering. It is of widespread occurrence in this country, and has given rise to numerous conjectures

[1] Schultz and Folsom have segregated a form of curly dwarf in which mottling is absent or masked.

regarding its nature. It is a complex trouble, and its appearance is not always due to the same cause or causes. It is probably often a manifestation of one or other of the constitutional (virus) diseases—particularly crinkle, but possibly also forms of streak or mosaic—in a state much altered by cultural conditions. There is no doubt also that rust may be caused by unsuitable soil conditions, such as lack of potash, raw compacted clay soil, uneven drainage, or excess of mineral salts washed into hollows. It is particularly common in Kerr's Pink and Tinwald Perfection, but it occurs freely on other common varieties. In the absence of virus diseases rust caused by cultural conditions is not transmissible and is not perpetuated. The effect on yield is generally serious.

THE FEEDING OF COWS.

Steamed Bone Flour as a Mineral Supplement for Milk Cows.

A. C. M'Candlish, M.S.A., and R. A. Berry, Ph.D.

Of all the mineral elements essential to animals only three, besides the components of common salt, are of much importance in practical feeding. These are calcium, phosphorus and iodine, and their importance lies in the fact that they may be deficient in some rations. Deficiencies in iodine, though quite uncommon in this country, are not unknown, but need no consideration here.

In comparison with the other ash constituents, relatively large amounts of calcium and phosphorus are required by farm live stock. The greatest demands for them are for the building and repair of bone and for milk production, and so the dairy cow requires much more calcium and phosphorus than any other farm animal.

As a general rule the roughage portion of a ration contains relatively more calcium and less phosphorus than do the concentrates. The best source of calcium is a good hay from a legume such as clover, while feeds that are specially rich in phosphorus are wheat bran and cottonseed. If plenty of good hay be fed the risk of the ration being deficient in calcium is minimised, and phosphorus is generally present in sufficient amounts in ordinary dairy rations.

In recent years it has been found that even though there be a large amount of calcium in the ration, a heavy milking cow may not obtain all the calcium she needs for body maintenance and milk production. There appear to be two main causes for this. In the first place a cow that is milking heavily cannot always assimilate nutrients from her feed fast enough to meet the requirements for production, and so she must draw on the supplies in her own body to keep her milk yield up to the proper level. This takes place for some time after calving, but later in the lactation and during the dry period the cow replenishes the

stores of nutrients in her body that have been depleted during the time of heaviest milk production.

The second cause of poor calcium utilisation by the cow, even in the presence of an abundant supply of it in the feed, appears to be the absence or deficiency of one or more of the food accessories. It is now recognised that this is sometimes the cause of the dairy cow not getting sufficient calcium for normal milk production, though she will maintain her milk flow at its normal level for a considerable time by simply drawing on her body stores of calcium and utilising this material for the elaboration of milk.

There are some cases, however, where the ration does not provide sufficient calcium for a milk-producing cow, and many attempts have been made to provide the necessary calcium by the addition of some supplement to the ration. Then, again, it is sometimes maintained that the addition of some source of calcium to the feed of the cow, even when calcium is not markedly deficient in the ration, will have beneficial effects. The present trial was conducted to test the value of steamed bone flour as a supplement to a normal dairy ration. Bone flour has been quite frequently used as a supplement to rations, as it contains both calcium and phosphorus, and though the utilisation of calcium and phosphorus by the animal are not absoluely interdependent, yet the assimilation of phosphorus follows that of calcium in a general way.

Experimental Work.—The present trial was conducted with eight Ayrshire cows which were producing normally. All were open when the trial started on 22nd February 1924. The animals were divided into two lots of four each, the lots being as similar as possible. The trial consisted of three periods of twenty-five days each, but the first five days of each period were looked on as transitional, and so the results have been compiled for the last twenty days of each period.

All animals received a roughage ration consisting of 60 lbs. swedes, 8 lbs. mixed lea hay and 6 lbs. oat straw per day. The concentrate mixture used was composed of 4 parts soy bean meal, 3 parts ground oats, 2 parts wheat bran and 1 part distillers' dried grains. The mixture was fed to all of the cows according to their production and condition. The amount of roughages fed was controlled by occasional weighings, while the concentrates were weighed out for each feed. All concentrates refused were weighed and allowed for in the trial. The hay and straw were each given at one feed, the concentrates at two, and the swedes at three feeds per day. Salt was kept in front of the cows at all times.

Milking was done twice daily, and the animals were out for about one hour each day for exercise and water in a pasture where a fair amount of good feed was available. The milk was weighed and sampled at each milking. A composite sample was kept for each cow during each ten-day period and the percentage of butterfat in the samples was determined by the Gerber method.

The mineral supplement was added to the grain ration of Lot I. in the first and third periods and to that of Lot II. in the second

period. It was fed at the rate of ½ lb. per cow per day. The steamed bone flour used was a proprietary brand specially prepared for feeding purposes and said to be sterile. It is looked on as being unpalatable, but when intimately mixed with the concentrates it was readily consumed.

The cows in both lots were fed the same allowance of roughages throughout, so that any possible variations in production are not likely to be due to that portion of the ration. When the average concentrate consumption during the first and third periods is compared with the amount consumed in the second period, and the periods during which no bone flour was fed are taken as the checks, it is found that with one lot the greatest amount of concentrates was consumed during the time of supplemental feeding, while with the other lot the reverse was true. When the two lots are taken together it is found that the average consumption was 11·3 lbs. per cow per day in both the check and supplemental periods. Consequently the amounts of concentrates fed could have no influence on the relative production of the animals.

Comparative Production.

Lot No.	I.		II.		Average.	
	Milk.	Fat.	Milk.	Fat.	Milk	Fat.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Supplement	2413	82·96	2511	90·64	2462	86·80
No Supplement	2388	79·64	2558	90·58	2473	85·11
Increase, per cent.	1	4	−2	0	0	2

If the milk and butterfat productions of the two lots be compared in the same way as were the amounts of concentrates consumed, it will be found that insignificant changes occur. In the case of Lot I. an increase of 1 per cent. in milk and 4 per cent. in butterfat occurred when the bone flour was fed, and with Lot II. there was a decrease of 2 per cent. in the milk yield and no change in the fat yield during the period of supplemental feeding. On the average there was no change in the milk yield and an increase of 2 per cent. in the fat yield when the steamed bone flour was fed—a variation of no importance.

During each of the three experimental periods the milk of three successive days was subjected to a standard rennet test by R. H. Leitch. Each sample represented the mixed milk of the evening and morning for one lot of cows. No significant variations in the acidities or rates of coagulation of the different samples of milk were found.

Summary.—From this trial it would appear that steamed bone flour, though not very palatable, can be easily fed to milk producing cows when mixed with the concentrate portion of the ration. The steamed bone flour has no marked effect on milk or butterfat production or on the rate of coagulation of the milk.

WATER FOR DAIRY COWS.

A. C. M'Candlish, M.S.A.

A plentiful supply of good drinking water is essential to the well-being of all types of farm live-stock, and for no class of cattle is this more important than for milk-producing dairy cows. A trial conducted at Holmes Farm emphasises the need of a plenteous supply of water, and shows that the requirements of the cow in this connection are even greater than is generally supposed to be the case.

Four cows were used in a trial which started on 14th February 1924 and continued for ninety days. The cows were on a ration of silage, hay, straw and concentrates, while two of the cows also received turnips during part of the time. In front of each cow was a drinking cup so that the animals had access to water at all times. The water for each cup went through a meter so that a record could be obtained of the amount consumed. The records of the water consumed and the milk produced by each cow have been tabulated. In the case of both water and milk a gallon is taken as ten pounds.

Milk Production and Water Consumption.

Cow No.	Milk.	Water.	Gallons of Water per Gallon of Milk.
	Lbs.	Lbs.	
1	1388	8,640	6·22
8	1013	7,490	7·39
20	2067	9,140	4·42
34	1539	7,780	5·06
Total . . .	6007	33,050	5·50

On the average the cows consumed 9·18 gallons of water per head per day or 5·50 gallons of water per gallon of milk produced. The cows varied greatly in their individual requirements and in their consumption from day to day. It is apparent, however, that the water requirements of milk-producing cows are large, and unless these requirements are met, maximum production cannot be sustained.

SALT FOR COWS.

A. C. M'Candlish, M.S.A.

Common salt is necessary for dairy cows, but unfortunately little work has been done in this country regarding the actual requirements of the milk-producing cow. At Holmes Farm four cows were under observation for a period of ninety days commencing 14th February 1924. A salt block was provided for each pair of cows and a record was kept of the salt consumed. The cows were fed silage, hay, straw and concentrates, and during part of the time two of the cows had an allowance of roots in

addition. The average milk production was 17 lbs. and the average salt consumption ·75 ozs. per cow per day.

At the end of the ninety day period the cows were turned to pasture, though they received straw and concentrates for the first ten days after going out. A record of the salt consumption of two of them is available for the first sixty days of the pasture season. During the second period the average production of the two cows was 18 lbs. of milk per day as compared with 20 lbs. during the first period. Their salt consumption dropped, however, to an average of ·02 ozs. per head per day as compared with an average of 1 oz. per head daily for the same two cows during the first period. From this it is apparent that the cows under consideration required a considerable amount of salt when on winter feed, but after they went to pasture their requirements for salt were markedly lowered.

In another herd under observation at Claunch, Sorbie, salt blocks were provided for eighteen cows at 1st February 1924, and by 1st September only three of the animals had consumed any appreciable amount of salt. The cows in this herd had not previously been provided with salt, while those at Holmes Farm were accustomed to salt blocks. It is worthy of note that the three cows in the second herd which did consume salt were young, and calves in the same herd consumed on the average ·03 ozs. salt per head daily when being raised by the self-feeder method.

It is generally considered that the milk-producing cow requires on the average about 1 oz. of salt daily, and as a consequence it is sometimes recommended that salt be mixed with the concentrates fed. From the results of the preliminary trial reported here this practice does not appear to be advisable. Salt is essential, but the amount required by a cow is controlled by her individuality and production and the nature of her ration. In addition it is probable that cows in different sections have dissimilar salt requirements, due to variations in the salt content of pastures, fodders and roots grown under different soil and climatic conditions, and until further information can be obtained on this problem, no definite recommendations regarding the salt requirements of dairy cows can be made, except that they should have access to it and then they will satisfy their own needs.

THE BEST AMOUNT OF ROOTS FOR COWS.

D. W. Steuart, B.Sc.

During the years 1921-23 a series of experiments with milk cows was carried out in Sweden, in which ground oats and roots —mangels and swedes—replaced one another in the experimental rations according to the following scheme:—

			Ground Oats.	*Roots.*
Group A,	...	...	12 lbs.	...
„ B,	...	...	8 lbs.	33 lbs.
„ C,	...	...	4 lbs.	66 lbs.
„ D,	...	...	...	99 lbs.

It was necessary, of course, to make slight modifications owing

to the varying proportion of dry matter in the roots; the basis being that 1·2 lbs. of average oats should replace 1·1 lb. of the dry matter in roots. In earlier experiments it had been found that 1·1 lb. of the dry matter in roots would replace a fodder unit of oats, viz. 1·2 lbs. It was desired to find whether these relative values held, independently of whether the root rations were heavy or meagre, to find whether there was a "best" quantity of roots to feed which, if exceeded, would result in a less efficient utilisation of the nutriment in the roots. Moreover information was desired as to the necessity—or otherwise—of "juicy" fodder in the winter feeding of milch cows. Full details of these experiments are given by Professor Nils Hansson in Swedish Report No. 268, 1924, which he summarises as follows:—

1. It has been found that the heavier the root ration, the worse the utilisation of the roots. Thus, small root rations have been utilised somewhat better than medium, and medium than large root rations. The diminished utilisation has been most marked when the roots were increased from about 66 lbs. per cow per day to 88-99 lbs.

2. Since previous experiments made here have shown that heavier rations of both hay and sugar beets are more poorly utilised than smaller rations of such fodder, these results should be the means of directing more attention to the question regarding the optimum amount of feeding stuff, which consideration is specially necessary in the case of fodders which by themselves are not well balanced.

3. The relative values of ground oats and roots have been confirmed. When medium root rations are fed—about 66 lbs. per cow per day—then 1 fodder unit of oats (1·2 lbs.) and 1·1 lbs. of the dry matter of roots have almost the same nutritive value.

4. When root rations are restricted to about 33 lbs. then a somewhat better utilisation results, which is shown both in the milk yields and in the live weights of the cows.

5. When the root ration is increased to 88-99 lbs. per head per day the roots are not so well utilised, shown by decrease in milk yield and in butter fat yield. This decrease is so considerable that if the result is calculated for the whole root ration then 1·2 lbs of the dry matter of the roots replaced a unit of oats. If, on the other hand, the result is calculated only for the amount of roots by which the maximum ration of 88-99 lbs. exceeded the average one of 66 lbs., then in that portion of the ration it needed 1·3-1·4 lbs. of the dry matter of the roots to replace a unit of oats.

6. The optimum quantity of roots to feed depends on the size of the cow, on the milk yield, on the concentration factor of the ration as a whole and on its composition in other respects. However we can state that cows of 1100-1200 lbs. and yielding 30-40 lbs. of milk daily have utilised root rations of 90-110 lbs. much worse than root rations of 65-75 lbs.

7. The cow's requirements of "juicy" fodder are satisfied by some 30 lbs. per head per day. Dry fodder alone produces a good result if the ration contains enough proteid and enough easily

digested carbohydrates. Too much ground oats causes digestive troubles.

Conclusion.—The amount of roots which it is advisable to feed to cows depends evidently very largely on an economic factor, viz., the relative cost of production of a unit of oats and a unit of roots. We may note too that Kellner's tables of starch equivalents underestimate the value of roots for milk production. This has been confirmed in Denmark.

The Concentration Factor in Rations.

D. W. Steuart, B.Sc.

Kellner took this matter into consideration by giving figures for the maximum and minimum limits within which the amount of dry matter in the ration might vary. The concentration factor can be readily measured by calculating the number of fodder units which 100 lbs. of the dry matter of a ration would contain. The following figures show the concentration factor for representative feeding stuffs :—

	Fodder units per 100 lbs. dry matter.
Concentrates.	
Decorticated groundnut cake,	139
Soya meal,	136
Barley,	117
Oats,	98
Bran,	92
Juicy fodder.	
Mangels,	93
Swedes,	93
Turnips,	91
Green fodder.	
Pasture grass,	80
Clover beginning to flower,	77
Clover in full bloom,	68
Meadow grass in flower,	63
Silage,	58
Long fodder.	
Clover hay,	54
Meadow hay,	50
Oat straw,	30

Of the various farm animals pigs require the most concentrated food. Fodder for fattening pigs must contain at least 100 fodder units per 100 lbs. dry matter, and it may go up to 110 or 120 in the final fattening period.

In the case of poultry feeding for high egg yields this matter is worth more consideration during the short days. With work horses the factor might be 55 for maintenance rations, rising to 65 with light work, 70 with medium work and 80 with hard work.

In the case of cows a maintenance ration might contain 35

fodder units per 100 lbs. of dry matter, but with milk production the concentration of the ration must increase somewhat as follows:—

Milk yield—lbs.	*Concentration factor.*
0	35
11	45
22	55
33	65
44	70+

A glance at the table of feeding stuffs will indicate how the foods might be chosen to get a suitable practical concentration of the ration for the animal in question. We may note in particular the position of roots in the table and even compare it with the figure for silage. It is obvious, too, that the question of the suitability of pasture without concentrates for high yielding cows depends partly on whether the herbage is young and juicy or is running to seed.

REFERENCE—"Rotfruktsgivornas Optimum," by Nils Hansson, 1923.

THE NUTRITIVE REQUIREMENTS OF POULTRY.

THE EFFECT OF ADDING VITAMIN RICH SUBSTANCES TO NORMAL RATIONS.

II. *Vitamin B or the water soluble Vitamin of Yeast.*

J. B. Orr and M. Moir, Rowett Institute; H. Newbigin, East of Scotland Coll. of Agric.; and G. Scott Robertson and M. Murphy, Ministry of Agriculture and Queen's University, Belfast.

If poultry be fed exclusively on refined cereal products, such as whole rice, as has been done frequently under experimental conditions, the birds soon develop symptoms of malnutrition. Some of the most striking of these symptoms can be made to disappear by the feeding of the germ and outer layers of the grain removed in the process of milling and refining. The constituent or property present in the germ and outer layers which has this beneficial effect has not been identified. It is generally referred to as "Vitamin B" or "B Factor."

Vitamin B is very widely distributed. It is present in practically all foodstuffs in their natural condition. Whole cereal grains or the milling offal containing the germ and outer layers of the grain, milk, eggs and yeast are all especially rich in this dietary factor. In experimental work, yeast or an extract from it has been very largely used as a source of this vitamin.

The fact that yeast has been shown to have a beneficial effect on health and rate of growth, when added to artificial diets fed to poultry in experimental tests, has led to the assumption that under ordinary practical conditions the addition of yeast to the ration

might lead to improvement in growth, egg production and health. Hence yeast, and also certain substances consisting of, or containing extracts of yeast have been put on the market, some of them under proprietary names, and their use advocated as a source of vitamin B.

There seems little doubt that the addition of yeast to certain ill-balanced rations improves the ration. It has not been shown, however, that the improvement is due entirely or even chiefly to vitamin B or any other unknown dietary factor. Yeast is rich in both protein and mineral nutrients. Dried yeast contains over 48 per cent. of protein and 10 per cent. of mineral matter. "Marmite," a commonly used food derived from yeast, contains, according to the analyses of Plimmer (1), 28 per cent. of mineral matter. Both proteins and mineral matter are, of course, essential food constituents, and the nutritive value of a ration depends very largely upon the amount and nature of these which it contains. If yeast be added to a ration deficient in either protein or certain essential mineral nutrients and the protein or mineral of the added yeast makes good these deficiencies, there would certainly be a beneficial result. The same beneficial result, however, would not be obtained if the original ration were properly balanced with regard to the protein and mineral matter. Obviously, one is not warranted in assuming that the whole value of yeast is dependent upon its content of vitamin B and in advocating its use merely as a source of this unidentified dietary factor. Indeed, there is no evidence to show that any ordinary ration fed to poultry is deficient in vitamin B.

Two points of practical importance have not yet been settled. First: Is the addition of yeast to a well-balanced ration such as an intelligent poultryman would use under practical conditions, followed by a definite increase in growth or egg production? and Second: If there is any improvement, to what extent is this due to the proteins and minerals present? The answer to the second question is of importance, because it might be possible to supply these known constituents from a cheaper source than yeast or some of its extracts which have been put on the market as poultry foods.

During the past two or three years a number of investigations have been carried out to obtain definite experimental evidence on these points. Though these investigations are likely to continue for some time before definite final conclusions can be drawn, some of the results already obtained appear to be of interest. The present communication is intended to give an indication of the results of experiments devised to show the influence on egg production of the addition of yeast to ordinary rations for poultry kept under practical conditions.

Experimental Data.—In all the experiments the birds used in the corresponding groups were of the same age and the same strain, and were kept under the same conditions with regard both to housing and extent and nature of run. In every case the birds had a run of limited range.

Experiment I. (East of Scotland Coll. of Agric.).—A ration which contained yeast and was being used in practice was fed to

one pen of 10 Ancona pullets. A control pen of 10 comparable pullets was given the same ration with the yeast kept out.

The ration consisted of:—

	Proportions.
Mash—Wheat Offal	60
S. G. Oats	15
Cooked Maize	15
Meat Meal	5
Bone Meal	2
Dried Yeast	3

The mash was fed *ad lib.* In addition, 2 oz. of grain per bird per day were given, and cabbage, oyster shell and grit *ad lib.* The run was on bare earth.

Table I. gives the result of a test of a full year's duration.

TABLE I.

Average No. of eggs per pullet.

	Yeast.		*No Yeast.*	
	No.	Av. Wt.	No.	Av. Wt.
Oct. to Jan.	27·6	54·2	19·6	58·0
Feb. to May	63·3	59·5	60·9	59·6
June to Sep.	53·1	60·3	62·0	58·5
Total for year	144·0	58·8	142·5	58·9

Experiment II.—(Rowett Institute)—A ration which was in use and which contained no yeast was fed to a pen of 11 Ancona hens. The same ration with the addition of yeast to the extent of 5 per cent. was fed to a comparable pen of 10 hens. The ration was:—

	Proportion.
Mash—Bran	4
Sharps	4
Crushed Oats	3
Gr. Maize	3
Fish Meal	2

In addition, 2 oz. of a mixture of equal parts of kibbled maize, wheat and oats per bird per day was fed with oyster shell and lime stone grit *ad lib.* The run was on rough pasture. Table II. gives the egg production per hen for a 12 month period.

TABLE II.

	Yeast.		*No Yeast.*	
	No.	Av. Wt.	No.	Av. Wt.
Oct. to Jan.	14·5	64·6	18·7	65·5
Feb. to May	64·2	64·3	63·6	65·6
June to Sept.	51·7	62·3	49·9	63·2
Total for year	130·4	63 5	132·2	64·5

Experiment III.—(Queen's University, Belfast)—The results referred to under this head are from an investigation undertaken

to determine the relative value for egg production of different proteins. This investigation will be dealt with in full in a future publication. It is only the test with yeast which is of interest in the present connection.

One group of 7 hens was fed on a ration containing calcium phosphate and yeast. Another group of 7 comparable hens was fed with the same ration without the yeast, but with the phosphate increased by the amount present in the yeast, to make it identical in the two groups. From 1st November to 30th September the number of eggs laid in the two groups was:—

TABLE III.

With Yeast.	*Without Yeast.*
778	779

Discussion of Results.—In Experiment I. the withdrawal of yeast from a ration which contained it led to no significant reduction in the egg production for the year. In Experiment II. the addition of yeast to a ration which did not contain it was not followed by an increased egg production. In Experiment III, where the control ration (*i.e.* without yeast) had the phosphates increased by the addition of sufficient calcium phosphate to balance the phosphate content of the experimental yeast ration, the egg production was practically identical in the two pens. These results seem to show that the addition of yeast to a ration such as well-informed poultry keepers would use does not increase the total egg production for the year.

A comparison of the seasonal variation in the egg production of the "yeast" and "no yeast" groups in Experiment I. shows that in the winter months egg production was greater in the "yeast group," though there was a corresponding decrease in the spring and summer months. The ration for this experiment contained a lower proportion of protein than that used in Experiment II., where no increase was shown. It was thought that this increased production in Experiment I. during the cold weather might be due to the protein of the yeast. As is well known protein stimulates all the processes concerned in the utilisation of food A series of experiments undertaken to test that theory will be reported later. It may be stated here, however, that the results obtained indicate that the theory is correct. In an experiment carried out at the North of Scotland College of Agriculture it was found that egg production was 41 per cent. greater in the early winter months in pullets on a high protein ration than in those on a low protein ration, and 24 per cent. higher in hens on a high protein ration than in hens on a low protein ration. Though this greater production and the high protein return were not maintained, it seems probable that in Experiment I. the increased egg production in the winter months in the birds receiving the yeast is to be attributed to the stimulating action of the protein in the yeast, and that, if the protein in the "control" ration had been increased by the amount of protein in the yeast added to the experimental ration, egg production would have been parallel in the corresponding groups.

There is little or no experimental evidence with which the results recorded here can be compared, except some experiments published recently by Soura, Knandel and Dutcher (2). These workers fed yeast as a source of vitamin B, and found that "pullets and hens, not forced for egg production and under natural conditions, employing a good ration with adequate yards, did not appear to need an additional amount of vitamin B to maintain their egg production and body weight." The results showed, however, that "yeast had a distinctly beneficial effect when White Leghorn pullets were forced to undergo a longer feeding and exercising period by the use of artificial light." Yeast was fed to the extent of 25 per cent. in the experiment with artificial light. It is very probable that the beneficial effect noted was due to the fact that this amount of yeast increased the proportion of protein and minerals in the ration. In all the other groups the addition of yeast seemed to make no significant difference in the egg production, so that, on the whole, the results obtained by these workers correspond with those reported here.

It should be noted that these results have no bearing upon the academic question of the requirements of birds for vitamin B. The experiments were designed to ascertain whether, under practical conditions, the addition of a substance rich in vitamin B would lead to increased egg production. While it is necessary to maintain an open mind, and to recognise that the addition of yeast or its extracts to certain rations would have a beneficial result, the general conclusions seem to be warranted that, when ordinary rations well balanced with regard to protein and mineral matter are used, the addition of any foodstuff as a source of vitamin B is unnecessary.

Conclusion.—Poultry kept under natural conditions and fed with a well-balanced ration do not need any additional food-stuff as a source of vitamin B.

The Mineral Requirements.

(Preliminary Communication.)

J. B. Orr and M. Moir, Rowett Institute; A. Kinross, West of Scotland Coll. of Agric.; G. G. Esslemont, Alness Poultry Station; G. Scott Robertson and M. Murphy, Ministry of Agriculture and Queen's University, Belfast.

During the past two years a number of joint investigations on the mineral requirements of poultry have been carried out at the Agricultural Institutions in Scotland and in the North of Ireland. The results of these investigations, which are still in progress, seem to be of practical importance, and as it will be some time before a full account of the different experiments can be published, this preliminary report is issued. It is thought that the nature of the results being obtained might be of interest to the growing number of poultry keepers who keep in touch with the developments of research, and have the facilities for testing under practical conditions on their own flocks the results of investigations such as these.

In all the experiments referred to, the poultry were fed on ordinary rations of a mash consisting of cereal products and of whole grain. Oyster shell or limestone grit or both were provided *ad lib.*, except in the case of the two experiments at Belfast, and the birds had a run on a limited range of pasture. The mineral mixtures used were added to the mash and intimately mixed with it so that in addition to the oyster shell or limestone grit, which the birds took according to their appetite or instincts, the added minerals were consumed with the mash.

Egg Production.—*Experiment I.* (Rowett Institute).—One pen of 14 Leghorn pullets were given a mash consisting of wheat offal, ground maize, ground oats and bean meal. Another experimental pen of 14 comparable birds were given the same mash, with the addition of 5 per cent. of a salt mixture consisting of bone meal 50 per cent., chalk 20 per cent., common salt 20 per cent., sulphur 5 per cent., iron oxide 5 per cent., and a trace of potassium iodide. The average egg production per pullet for the two groups for a complete year was as follows:—

Control Pen.		*Experimental Pen* (Salt Mixture).	
No.	Aver. Wt.	No.	Aver. Wt.
107	60·0 grms.	178	57·6 grms.

Experiment II. (West of Scotland Coll. of Agric.).—This experiment was conducted with two pens, each of 11 Leghorn pullets. The mash and mineral mixture used were the same as in Experiment I. The average egg production per pullet for the two groups for five months was as follows:—

Control Pen.		*Experimental Pen* (Salt Mixture).	
No.	Aver. Wt.	No.	Aver. Wt.
61·1	51·1	71·4	59·9

Experiment III. (West of Scotland Coll of Agric.).—The mash used in this experiment contained blood meal instead of bean meal, but the mash and mineral mixture were otherwise as in Experiments I. and II. The birds used were Leghorn pullets. The experimental period was from 1st September to 6th December. The egg production for the 12 birds for the period was as follows:—

Control Pen.		*Experimental Pen* (Salt Mixture).	
No.	Aver. Wt.	No.	Aver. Wt.
139	46·6	263	46·5

The number given for Pen I. includes 37 small eggs of about an ounce weight, laid by two of the birds in the pen. These are not included in calculating the average weight.

Experiment IV. (Queen's University, Belfast).—The pullets used in this test were birds carried on from a growth experiment in which one of the groups had received a mineral mixture in the mash. The same mineral mixture was continued in the mash after the birds began to lay. The mineral mixture used in this case was based upon the mineral composition of egg. Neither oyster shell nor limestone grit were supplied. There were 9 pullets

in each pen. The number of eggs produced from July to October in the two groups was as follows:—

Control Pen.	*Experimental Pen* (Salt Mixture).
73	142

Growth. — A number of experiments were carried out to determine the influence on growth of the addition to the ration of the mineral mixture, which had been found to improve egg production when fed to adult birds. The tests were begun when the chicks were from 3 to 5 weeks old, and continued usually until they were about full grown.

The general result obtained was that the addition of this mineral mixture retarded growth, especially in the younger chicks. In the older birds, little or no difference was noted. The figures for three experiments may be quoted. In an experiment at the Rowett Institute with Leghorn chicks, the average weight on September 2nd, of the chickens hatched on 13th April, was 41 ozs. in the "mineral group" and 46 ozs. in the "non-mineral group." In an experiment carried out at the West of Scotland College, the average weight of Leghorn chicks at the end of 20 weeks was 38·4 ozs. in the group receiving the extra minerals, and 37·6 in the "non-mineral group." In an experiment at Alness Poultry Station, a group of 15 pullets fed for 5 weeks on mash containing the mineral mixture made a total gain of 6·75 lbs. A comparable group fed on the same mash, but without the added mineral, made a gain of 7·5 lbs. in the same period.

In an experiment at Queen's University, Belfast, instead of the empirical mineral mixture used in the first tests, the mixture used was based upon the composition of egg. The chicks were put on experiment when 8 days old. At the end of the sixteenth week, the average weights of the birds were as follows:—

	Control Pen.	*Experimental Pen* (Salt Mixture).
Pullets -	801 grms.	855 grms.
Cockerels -	866 „	1346 „

Discussion of Results.—The increased egg production which accompanies the addition of the mineral mixture to the mash and the increased rate of growth in the Belfast experiment is well beyond the limits of experimental error. It is obvious that the mineral content of the ration is an important factor in both growth and egg production and warrants much more attention being given to it in practice.

The fact that in the growth experiments the addition of the mineral mixture to the ration used was in some cases followed by a decreased rate of growth is worthy of special note. In certain other experiments, which will be reported later, in which fish meal constituted part of the basal ration, the addition of certain mineral mixtures appeared to decrease egg production. Fish meal contains usually from 15 to 25 per cent. mineral matter, and in those cases where the addition of a mineral mixture was followed by decreased egg production, there was doubtless, after the addition, an excess of certain mineral elements, which was harmful.

The mineral content of the whole ration after the addition of the mineral mixture must be balanced to suit the requirements of the poultry if the best results are to be obtained. Unfortunately our knowledge with regard to the mineral requirements of poultry is very limited. Hence in the present state of our knowledge it is impossible to do more than make empirical trials of various mineral additions and be guided by the results obtained in making better adjustments for future trials.

It is clear that the minerals which should be added to the ration depend upon the minerals already present in the ration, and consequently each ration requires its own mineral mixture to adjust it to the requirements of the poultry. Hence it is irrational to expect that any stock mineral mixture will give beneficial results when added indiscriminately to different rations. In some cases it might be markedly beneficial, in other rations already rich in minerals it might lead to an excess, and consequently be harmful. In general, however, it looks as if cereal rations could be improved by the addition of lime, phosphates and common salt, and it seems as if it would pay the well informed poultryman to make tests along these lines.

NOTE.—*It is intended to publish in the near future a full report of this work on the mineral requirements of poultry, together with an account of the previous work on the subject, which has served as a guide in these investigations.*

REFERENCES.

(1) *Biochemical Journal*, vol. xvii., p. 772 (1923).
(2) *Poultry Science*, vol. iii., p 204 (1924).

Agricultural Research Conference.

THE Second Annual Conference of Agricultural Research workers and members of College staffs was held at Glasgow and Kilmarnock on 24th and 25th July last. There was an attendance of close upon a hundred representatives of the various Research Stations, the Agricultural and Veterinary Colleges, and the Board of Agriculture for Scotland.

The first day, when the Conference met in the Agricultural College Buildings, Glasgow, was taken up with the reading of papers and discussion thereon, and the second day was occupied by a visit to the College Farm, Gardens, Apiary, Dairy School and Dairy Research Department at Kilmarnock.

The subjects dealt with in the papers and discussion are as undernoted.

Principal Paterson: (a) "*Cattle-Feeding Experiments.*"—This paper dealt only with summer feeding of cattle and summarised the results of experiments carried out at the College Farm, Kilmarnock, on Feeding *versus* Manuring.

The investigation is now in its seventh year, and the results on the basis both of individual progress and of financial returns favour direct feeding.

The manure applied per acre amounted to a total of 25 cwts. basic slag, 2 cwts. superphosphate, 1 cwt. potash salts, 30 per cent., 1 cwt. sulphate of ammonia.

The feeding stuffs consumed per acre amounted to 2 tons 4 cwts.
The average weekly increase from 68 cattle has been as follows :—

	Increas per head per week.
34 grazed on manured section . .	15·4 lbs.
34 grazed on unmanured section and receiving concentrates . . .	17·6 lbs.

The average weekly increase for each year was as follows :—

	Manured Section.	*Unmanured Section.*
1918 . . .	11·5 lbs.	13·4 lbs.
1919 . . .	17·3 lbs.	19·4 lbs.
1920 . . .	17·3 lbs.	18·4 lbs.
1921 . . .	14·4 lbs.	16·6 lbs.
1922 . . .	17·4 lbs.	18·4 lbs.
1923 . . .	16·5 lbs.	20·0 lbs.

The direct feeding method has proved the superior method by as much as £1 per acre per annum or £6 per acre for the six year period.

(b) "*Pig Feeding Experiments.*"—These dealt with dry and wet feeding, the effects of feeding fish meal, the optimum amount of whey in pig diet, the influence of adding certain minerals to the diet, the feeding of cod-liver oil, a comparison of indoor *versus* outdoor feeding, and the best weight at which to slaughter so as to secure the highest percentage of carcase weight.

"*Production of Pure Milk,*" *by Professor Leitch.*—This paper is given in the current issue of the JOURNAL (see page 7)

"*Variation in Composition of Cheese,*" *by Professor Berry.*—Over 2,841,000 cwts. of cheese, equivalent to about 290,000,000 gallons of milk, were imported into Great Britain in 1923. 57 per cent. came from New Zealand, 41 per cent. from Canada, and the remainder from the United States. In view of these large importations it was considered desirable to make a comparison of the nutritive value, as judged by chemical composition, of imported and home made cheese. As cheese varies greatly in composition, it was necessary to study the effect of the causes which are likely to produce variation, before proper comparison could be made. Some of the results so far obtained are incorporated in this paper, which is part of a research connected with the chemistry of cheese making.

There are nearly 250 varieties of cheese, and as cheddar forms over 90 per cent. of the importations, attention was first confined to this variety. The principal factors which cause variations are : 1. Composition of the milk from which cheese is made. 2. Losses of cheese solids in the process of manufacture. 3. Changes during ripening of cheese. These factors were dealt with in detail.

Different methods of sampling cheese for analysis were described. The average composition of the dry solids in imported and home-made cheddar cheese made during the past twelve months was as follows :—

	Home Made.	*New Zealand.*	*Canadian.*
Fat, ...	51·1	33·3	51·6
Ratio of Protein to Fat,	39·9	36·9	39·2
Protein, ...	0·77	0·69	0·76
Ash, ...	5·90	5·20	5·50
Average moisture, . .	35·70	32·60	29·70

Cheese Standards.—There is no legal standard for cheese in this country, and little uniformity exists in the standards adopted by other countries. In dry cheese from whole milk a minimum of 50 per cent. fat is adopted by New Zealand, Australia and United States Department of Agriculture ; a 45 per cent. standard by Canada, Netherlands, Switzerland, Minnesota ; a 40 per cent. by South Africa. Some countries also adopt a system of grading on points.

From the results of analyses of home made cheese a 50 per cent. standard for fat, on the whole, would be too high for this country.

"*Variation in the Composition of Milk,*" *by Dr Tocher.*—It is important for the public and also for the State Authorities to know how far each of the individual constituents in milk varies, as one passes from the milk of one cow to

that of another cow. About 750 samples of milk from 750 individual cows had been analysed for each of the constituents of milk—namely, butter fat, lactose, albumen, casein, globulin and ash. The physical properties, specific gravity, refractive index, freezing point, and quantity per milking were also determined. When individual cows are considered, there is wide variation in all the constituents of milk. The extent of the reduction in variation of the constituents was given when herds of varying sizes were considered. It was shown that about 10 per cent. of the samples of milk from individual cows fell below 3 per cent. butter fat; and over 24 per cent. of all similar samples fell below the presumptive limit of 8·5 per cent. of solids not fat. The conditions under which milk of standard quality could be produced were described in detail. It was shown that all the constituents were more or less correlated, and therefore selection for one constituent involved indirect selection for other constituents in varying degrees.

"*Dried Milk and Clean Milk*," *by Dr Lauder and Mr A. Cunningham.*—This paper appeared in the July 1924 number of the JOURNAL.

"*Some Oat Characters*," *by Mr O'Brien.*—In the comparison of oat varieties grown under similar conditions, from selected seed of the same age, remarkable differences were observed in the rate of growth during early stages.

These differences are correlated with the fat content of the grain.

Oats of the Abundance class showed most rapid development and have a relatively low fat content. Oats of the Potato type were intermediate in both characters. Black Oats, which showed decidedly slower seedling growth, have a high fat content; exceptions being Supreme and Bountiful, which are rapid growers and have a low percentage of fat. The Sandy-Tam Finlay type were by far the slowest in early development and have the highest fat content of all.

The slow-growing varieties suffered severely from grub, while the more rapid-growing varieties escaped.

It is advisable, therefore, in grub-infected districts, to use only oats which develop rapidly in earlier stages.

The assertion is made that greater production could be obtained if more attention were paid to the root development of the plant, since greater power of the roots to take up food-making materials from the soil results in greater production of foliage and grain.

This power is partly dependent on root mass and on the ability of roots to excrete acids. Both of these factors can be selected and bred for, since root mass, although it varies with variety, is more or less constant in any one variety and is an important systematic character. The power of the root to excrete acids also varies with variety.

In general, late varieties have large roots with low excretory powers and are straw producers; whereas early varieties have small roots, relatively high excretory powers, and are grain producers.

Selection of deep-rooting and, consequently, drought-resistant strains should be made from suitable varieties for dry sandy soils and for poor soils.

For soils in good condition shallow-rooting strains should be chosen, as these tend to give a larger proportion of grain to straw and would resist lodging better. The importance of root characters in plant breeding is also emphasised.

"*Tuberculosis and Milk*," *by Dr Simpson.*—The latest knowledge on the connection between bovine and human tuberculosis was summarised, and the importance of a practical policy being adopted for the elimination of tuberculous cows was emphasised.

"*A Feeding Standard for Dairy Cows*," *by Mr M'Candlish.*—A feeding standard is a statement of the nutrients or energy required by animals for maintenance and production — growth, fattening, fœtus-building and milk secretion. In the last century about twenty standards for use with dairy cows have been elaborated. The first were founded on the weights of the various feeds and were succeeded by others based on total nutrients, digestible nutrients and energy values.

All have their limitations as they take into consideration only protein, carbohydrate and fat, disregard ash and vitamines, and look on all proteins as of equal value. Errors are introduced by variations in the composition of feeds.

Difficulties also rise due to the maintenance requirements varying with age, condition and other factors.

The standards in use are of two main types—based on digestible nutrients, as the Morrison standard, and on digestible true protein and net energy, as the Armsby and Kellner standards. The limitations mentioned apply to both types and others apply to those based on net energy.

The Armsby and Kellner standards use "true" protein and so give no value to the non-protein nitrogenous constituents of feeds. At present little is known regarding the value of this group, but it is of very considerable value in some cases.

The Morrison standard is perhaps on a more solid foundation at present than the Armsby and Kellner standards. It can be rendered more convenient, however, by expressing it in independent rather than dependent terms—digestible crude protein and digestible carbohydrate equivalent, rather than digestible crude protein and total digestible nutrients.

"*Inheritance of Milk Yield*," *by Dr Finlay*.—The inheritance of mild yield is conditioned by complex genetic factors.

The influence of sire and dam appears to be equal in relation to fat content and quantity of milk produced. In the attempt to improve pure-bred cattle attention must be paid to individuality, the association of certain characters with high milk yield, the record of performance of ancestors, descendants and close relatives, and line-breeding.

"*Hygiene of the Byre*," *by Professor Linton*.—The hygienic construction of cowsheds and its connection with clean milk production were discussed and special stress was laid on points concerning which there is marked difference of opinion among those interested in the erection of byres. Slides were shown illustrating the points raised. While it was admitted that method in the production and handling of milk took premier place over the actual building, one must not lose sight of the fact that properly constructed hygienic building stands for healthy cows, less liability to the spread of tuberculosis, comparative ease in keeping the cows clean (thus giving encouragement to the workers), and less expenditure in daily labour; and lastly, but by no means least, one must not forget the effect of environment on the mind of the workers. It was possible to erect a satisfactory byre at a reasonable cost, and simplicity in construction should be the keynote in the design. The most satisfactory shed was that which was produced by the co-operation of architect, veterinary hygienist and dairyman.

"*Fundamental Investigations on Basic Slags*," *by Dr M'Arthur*.—The varied results obtained from the use of basic slag, together with the varied analyses and citric solubilities of the slags used, seem to demand an investigation into the molecular composition of the slags. Little was known - apart from the percentage composition and the citric solubility—of the actual phosphatic and other compounds present in a basic slag. Fortunately, however, the optical data of crystals picked from unground, or "ball," slags, were available for consultation.

The following methods were used and the results obtained from each method were correlated.—

1. A petrographic study of thin sections of basic slags.
2. A metallographic study of polished surfaces of basic slags.
3. Pot and field trials.

The outstanding result obtained was that the molecular composition of basic slags was very varied, but the great difference was between the slags made with and those made without the addition of fluorspar.

The citric solubilities of basic slags, as was to be expected, varied according to the particular phosphatic compound or compounds present. The results of *pot and field trials* obtained seem to indicate that under particular soil conditions the dicalcium silicate present in open hearth fluorspar basic slag can function as an ingredient for the removal of soil sourness.

The problem engaging attention is to determine the values to the plant of the varied molecular combination of phosphorus silicon and calcium, and in this respect it is claimed that the molecular composition or constitutional formula of a slag is of more importance than the actual percentage composition.

It is suggested that the chemical physiology of the nutrition of a particular plant species will be influenced by the molecular constitution of the phoshates supplied, and that not until a complete study of the metabolism of the individual phosphatic compounds to be found in slags is known will a solution of the "basic slag problems" be within sight.

Egg-Laying Trials.

THE following article is the substance of an address delivered at a recent meeting of the Scottish National Poultry Council by Miss Murphy, Poultry Inspector under the Ministry of Agriculture of Northern Ireland.

Laying trials occupy a very important place in the poultry industry to-day, and while small trials may be of doubtful value, there is no question as to the good influence of the Great National Trials in focussing attention on breeding for increased fecundity.

The objects for which laying tests are carried out may be shortly stated as follows:—

(1) To stimulate interest in breeding for increased numbers of *saleable* eggs. This includes the elimination of faults from pure stocks (for example, the production of small eggs, which injures not only the breed or variety but also the national reputation of the industry).

It is a simple matter to breed heavy layers of small eggs—the typical sprinter—but very difficult, with certain breeds, to build up a strain where 75 per cent. of the pullets lay 2 oz. eggs within 3 months of beginning to lay. A test which fails adequately to penalise the producers of small eggs is doing irreparable injury to the strains within its sphere of influence.

The leading trials have now adopted uniform methods of grading so that the term "first grade egg" has a definite meaning. Home recorders should be equally particular about the grade of eggs laid. It is not necessary to weigh these eggs every day as is done at laying tests. Weekly grading will give as accurate an index of the rate of improvement as weekly weighings of a cow's milk give of her annual yield. I have seen on one pedigree farm a very simple method adopted. An egg grader is used every day, and in entering the egg a stroke is used to denote an egg of 2 oz. or over and a O to denote one under 2 oz. Thus an accurate record of the number of second grade eggs is on permanent record and gives valuable guidance in mating up breeding pens the following year. It is doubtful if this system could be followed with very large flocks, but it is of the utmost importance to know how soon a pullet's egg reaches first grade.

One of the most objectionable types of hen to use in the breeding pen is the bird which has laid a large number of second grade eggs of which there is no record. The daughters of such hens are not likely to be any better. It is for this reason that reports of laying tests should publish the individual numbers of second grade eggs laid. Two pullets each laying 250 eggs may be of very different value, but without accurate knowledge of the size of their eggs one cannot differentiate between them.

(2) To locate strains in which the desirable characters have fixed. It is not necessary to win a laying test to prove the posses-

sion of good stock, but it is necessary to send to a test year after year pullets that are good layers. The owner who year after year can send a pen that puts up a score averaging somewhere about 200 eggs for each pullet is a good breeder and a successful one, should his pen never win a prize.

(3) To accumulate data which is valuable in various ways. Costings, for example, which are so very difficult on the ordinary farm, are much more easily available from the books of a laying test.

In sending particulars of entries, dates of hatching, records of parents and similar particulars are often very carelessly done. "February" or "March" as a date of hatching conveys nothing. If the absolute accuracy of the given particulars could be depended upon, a vast mass of most useful data would be accumulated in a few years. Breeders do not, as a rule, recognise the value of accurate pedigree work. Amongst the annual crop of pullets, and even amongst the half-dozen chosen for a test, it frequently happens that there are some of outstanding merit and others that are valueless. It is quite a common thing for the owner to be quite ignorant of the parentage of either the good or the bad birds. If any real progress is to be made, the parentage ought to be known, if not the actual individuals that produced the chicken, at least the pen from which it was bred. It is well known that male birds vary greatly in the number of high producing daughters they give.

In framing rules for laying trials several points of controversy arise. Probably the most important is the rival methods of scoring by number or by value. In the Irish trials the latter method has been employed from the second year, as it was then found—and there has never been any reason to change the view—that it was the only way of giving adequate recognition to the good winter layers. A reliable supply of winter eggs is essential to countries which have a large export trade; therefore the winter yield and the necessity for focussing the attention of breeders on this point are of vital importance. A pen that puts up a really good winter record is the most valuable breeding pen. Under the system of scoring by values it keeps its place in the order of merit as against the pen with a poor winter but a very heavy spring and summer record.

The second very controversial point is that of replacements.

In comparing the scores of laying tests it makes a great difference whether replacements are allowed or not, and tests are comparable only where the same rule as to replacements holds. The pen that comes through a test with a big score and with the team up to full strength is of much greater value than a pen with an equal score, but with the reserve bird called up to fill a gap caused by the death of a pullet. The "reserve bird" method involves the loss of some eggs from the score, because eggs laid at night or in the litter are frequently not recognisable as belonging to the pullets that laid them and guess work can find no place in a test. A highly skilled recorder will, of course, lose fewer eggs in this way than a person less efficient, but the difficulty always remains in greater or less degree.

Whatever rules are adopted the tendency should always be towards a higher standard; any leaning in the opposite direction is a reflexion on the capacity of breeders of highly fecund stock.

The chief points to be observed in choosing a team of pullets are their breeding, the number and size of eggs of the dam, the age at which she began to lay, the pedigree of the sire and his breeding record. Particular attention should be paid to head points, texture of the skin and condition. Undersized and mismarked pullets should, of course, be eliminated.

A difficulty often arises about the most suitable age for a laying test. It is not so much a question of age as of development. Take the case of a flock of pullets all of the same age and from the same pen. Some are laying on October 1st, and some are only beginning to redden up and may not lay for weeks. Those which are laying are the best layers of the flock, those which show few signs of laying are the slow developers By sending the former you risk a moult for some of the pullets, by sending the latter you risk your own reputation as a breeder. The only safe method is to have batches of pullets of different ages.

If pullets show signs of laying, they should be trained to the use of the trap nest and should be handled and made tame and friendly. If not tame from chickenhood a great deal can be done by taking them off the perch at night, stroking them and talking to them. Such pullets will not later on resent being taken from the trap nests, and their owners earn the gratitude of the recorders. Wild pullets are the despair of the manager and never win the championship of the test.

In the feeding of pullets intended for a test many mistakes are made. The chief of these is the giving of too many tit-bits. While this has the effect of getting the pullets into the required condition, it has also the effect of making them fastidious about their food. Pullets accustomed to all kinds of delicacies do not relish the plain food supplied at a laying test and will probably refuse to eat it. No test makes any secret of the foods used, and competitors ought to make themselves familiar not only with the kind of food used, but also with the time of feeding.

Pullets should never be taken straight from free range and sent to a test. Deprived of their liberty, they fret and feed badly, too often they moult. Apart from the question of making them familiar with the new conditions there is the question of isolation. All pullets should be isolated for some time before despatch, and when being sent they should be placed in new or in clean packages. Every pullet should be carefully examined for lice and for scaly leg, not on the day of despatch, but on the day she is placed in the isolation pen.

Breeders and laying tests have really the same objects in view, the advancement of the industry. Our pure bred stocks are the foundation stones of our success, and breeders the pillars on which our national reputation as stock raisers rests. Laying trials show the world what our birds are capable of doing, but the hearty co-operation of breeders will alone make these trials capable of doing the maximum good.

Notes from Craibstone.

Golden Wonder Potatoes.—In spite of the many new varieties that have been introduced within recent years, Golden Wonder, which has been for a considerable time in cultivation, still retains its reputation for quality, and its popularity on this account is yearly increasing, as is clearly shown by the returns published by the Board of Agriculture regarding the acreages under the different varieties of potatoes. The following are the acreages under Golden Wonder in Scotland for the last four years:—

1921—5,305 acres.	1923—12,403 acres.
1922—7,862 „	1924—13,220 „

While giving a crop of excellent quality, Golden Wonder, however, is generally found to be a poor yielding variety. From our experience with it we are inclined to believe that the poor yield usually got is not altogether due to any inherent fault in the variety itself, but is also due to three factors over which the farmer has very complete control.

First, Golden Wonder sprouts very slowly in springtime, and no doubt its excellent keeping qualities during the summer are due, in the main, to this fact. When planted without previous sprouting it comes very slowly, and has often not reached its maximum growth in late autumn when the frosty weather sets in, and the tubers have, consequently, not reached anything like their full growth. With such a slowly sprouting variety as Golden Wonder, and a variety, too, which requires a long season of growth to produce maximum yield, sprouting is of really more value than with varieties that sprout more readily and have a comparatively short season of growth.

During the past few years several trials have been carried out with Golden Wonder, using sprouted and unsprouted setts, and the following result of one of these trials very clearly shows the advantages of sprouting, and that, further, if sprouted, Golden Wonder is by no means a poor yielder. It will be noticed, too, that not only is the total yield very much increased, but that there is, proportionately, a very much larger amount of ware potatoes.

	Ware.		*Seed.*		*Small.*		*Total.*	
	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.	Tons	Cwt.
Sprouted, . .	7	12	4	4	1	3	12	19
Unsprouted, .	3	8	3	14	1	1	8	3

Many farmers still complain about the large amount of labour and special space entailed by the sprouting process. Although we do not agree with them that sprouting has this disadvantage to any marked extent, yet, if they do object, we may point out that, especially with Golden Wonder, boxes are not altogether necessary. If the seed in bags is put into a byre a few weeks before planting time, a satisfactory sprout should be got in that time. Care must be taken to examine the tubers to see that the sprouts are not too long and tender, but our experience is that, on account of its slow sprouting habits, there is no very great danger of this. This is certainly not so good as boxing, but it does entail considerably less labour.

Another factor that undoubtedly militates against the yield of Golden Wonder is the fact that there is scarcely a strain to be got that is not affected by mosaic, a disease that has been so largely written about recently that a detailed description of it is unnecessary here. It is sufficient, therefore, to say that the mosaic is carried on from season to season through the setts, and that therefore it is of the very first importance that a mosaic-free stock should be secured.

As showing the great prevalence of mosaic in Golden Wonder, samples of seed were got from 90 different places all over the country last season, and it was found that some of these were very badly affected, some, on the other hand, only slightly, but there was not a single one out of the whole 90 that was entirely free from it.

We have been attempting, therefore, for the last few years to raise mosaic-free stocks, the method adopted being to examine the growing crops and keep seed from plants appearing to be entirely free from mosaic. The seed from each plant has been kept separate and planted separately, and this has been repeated for several seasons. Even yet, however, we have not succeeded in raising a strain that is totally free from mosaic, although a very marked improvement has been made

One point of great interest that has been noticed is that the plants attacked by mosaic ripen much earlier than those that are free from it. The mosaic-free plants, therefore, having a longer season of growth, naturally give a heavier yield, and so far as quality is concerned they are quite equal to the earlier-ripening and lighter-yielding strain attacked by Mosaic.

As an indication of the improvement effected by selection we give the following figures from our trials for the past season :—

	Ware.		*Seed.*		*Small.*		*Total.*	
	Tons	Cwt.	Tons	Cwt.	Tons	Cwt	Tons	Cwt.
Selected stock,	3	3	5	15	1	12	10	10
With mosaic,	1	12	4	14	1	12	7	17

The yield of Golden Wonder can also be very greatly increased by proper manuring. A slowly maturing variety like this, and one that is naturally of good quality, may be, and ought to be, more heavily manured than early maturing varieties that are not naturally of such good quality. In the season 1923 an experiment was carried out with Golden Wonder with different quantities of manure applied along with dung, the latter being used at the rate of about 12 tons per acre. The mixture used consisted of 1 part sulphate of ammonia, 4 parts superphosphate (30 per cent.), and 1 part muriate of potash, and was supplied in the following quantities—3 cwt, 6 cwt., 9 cwt., and 12 cwt. per acre, one plot, of course, being left unmanured for purposes of comparison.

	Tons	Cwt.		Tons	Cwt.		Tons	Cwt.
No manure—	8	15	6 cwt.—	10	4	12 cwt—	11	5
3 cwt. —	9	6	9 ,, —	11	6			

Here, evidently, the limit of profitable manuring is reached at 9 cwt. per acre. Boiling tests showed that the quality from the 3 cwt. per acre plot was not appreciably better than from the 9 cwt. plot.

Animal Nutrition. Wood, T. B., University Tutorial Press, London, 1924: in 16° pp., VIII.+226.

Reviews.

As stated by the author in the preface, this book (which deals with the use of products o the soil for animal nutrition) aims rather at a well co-ordinated and clear enunciation than at giving exhaustive information regarding every detail of animal nutrition. For those who desire fuller information a list of suitable works is given in the text.

In the chapters devoted to the calculation of rations the author has adopted a rather novel point of view, substituting for the system of model rations, maintained with very few changes since 1864 (the year of Wolff's first publication), a much more elastic system of calculation according to the nature of the production desired from the animals. The book, which is completed by an analytical index, includes the following chapters:—Vegetable and animal metabolism—constituents of the plant—starch and sugar—cellulose and other less important carbohydrates—oils—proteins—other less abundant vegetable constituents—composition of milk—analyses of fodders—green forages—forage roots—cereal grains and their derivatives—pulse grains—analyses of linseed cake—various fodders—digestibility of fodders—model rations—comparison of the methods of slaughtering and metabolism for the determination of such rations—equivalents in starch (Kellner's method and others)—calorimetry; metabolisable energy — net energy—maintenance requirements; pig nutrition — rations for winter production in cattle—fattening of cattle in pasture; nutrition of lean cattle; nutrition of sheep—rations for milch cows—nutrition of working horses—purchase of fodder.

Practical Bacteriology; an introductory course for Students of Agriculture, by Andrew Cunningham, B.Sc., Advisory Officer and Lecturer in Bacteriology, Edinburgh and East of Scotland College of Agriculture. (Edinburgh, Oliver & Boyd. 7s. 6d. net.)

The publication of Mr. Cunningham's Introductory Course in Practical Bacteriology for agricultural students shows the important place which bacteriology is now taking in the curriculum of the present day student of agricultural science. Not so many years ago the subject was dealt with as either a branch of agricultural chemistry or a few lectures were given by a medical bacteriologist, whose interest was generally medical rather than agricultural. So great, however, has been the development of agricultural bacteriology in recent years in its manifold applications to dairying, soil chemistry, plant diseases and animal diseases, that in the larger agricultural colleges a special department is now devoted to its study.

Mr. Cunningham's book covers the course in agricultural bacteriology taken by students in the Edinburgh and East of Scotland College of Agriculture. It appears at a most opportune time, since there is no book available at present which covers the requirements of such a course.

The first chapters are devoted to the study of general biological technique; the structure and use of the microscope, and of the special apparatus of a bacteriological laboratory, such as sterilisers

and incubators, are described in detail; then follow directions for the sterilisation of apparatus, and the preparation of the various culture media.

The succeeding chapters deal with the bacteriology of milk and dairy produce, soil and farmyard manure, plant diseases and animal diseases. In the concluding sections the classification of bacteria, staining reagents and indicators are adequately treated.

The general style of the book is admirable, the treatment of the different sections is adequate and well balanced, while the directions for the practical exercises are clear and concise. The work has already been in use for some time in Mr. Cunningham's laboratory in manuscript form, and the methods have had the advantage of thorough revision.

The book will appeal to all teachers of agricultural bacteriology, and its use will greatly lighten the heavy work of the practical courses.

Longevity of Seeds.

THE longevity of seed is dependent on the circumstances under which the seed is grown, its initial capacity for germination, its water content just after harvest, its state after drying and cleaning, and the conditions of moisture and temperature in storage; seeds well grown, harvested without injury, of high initial germinating capacity, stored cool and dry, retain their vitality longest, subject to great variation, however, between species and between different samples of the same species.

In leguminous species, *e.g.* clovers, samples which germinate rapidly and well retain their capacity to germinate unaltered for the first three seasons; a marked reduction occurs in the fourth year. In general, samples containing hard seeds keep longest, while those without hard seeds, and seeds which have been scratched, deteriorate rapidly after about the fourth year. The seed of lucerne retains its vitality longer than any of the other cultivated legumes. The number of hard seeds in most cases remains constant; in exceptional cases it increases. Clover seed may live for over 25 years, and may after that period still contain hard seeds which will germinate if scratched. Rapid germination is co-ordinated with the capacity to germinate well in soil.

The mortality in a sample of grass seeds, which germinates rapidly and well, is small until the third season, and even then it is not marked. In the fourth season and subsequently there is rapid deterioration, which is complete in the seventh or eighth year.

Seeds of beet and mangel of high quality retain their germinating capacity unaltered during the first four or five years, and maintain good germination from the sixth to the ninth year. Root seeds with an initially high germinating capacity retain this unaltered for the first four to five years, and are not totally useless until the thirteenth or fourteenth year. Rapidity of germination decreases more rapidly than total germinating capacity.

Annual Estimates of the Produce of Crops.

THE following statement regarding the produce of crops for 1924 was issued on 28th November:—

Preliminary Statement showing the ESTIMATED TOTAL PRODUCE and YIELD PER ACRE of Wheat, Barley, Oats, Beans, Hay, Potatoes and Roots in SCOTLAND in the Year 1924, with COMPARISONS for 1923, and the AVERAGE YIELD PER ACRE of the Ten Years 1914-1923.

CROPS.	Estimated Total Produce.		Acreage.		Average Estimated Yield per Acre.		Average of the Ten Years 1914-1923.
	1924.	1923.	1924.	1923.	1924.	1923.	
Wheat ..	*Tons.* 49,000 *Quarters.* 231,000	*Tons.* 64,000 *Quarters.* 290,000	*Acres.* 49,449	*Acres.* 58,789	*Cwt.* 19·8 *Bushels.* 37·3	*Cwt.* 21·8 *Bushels.* 39·5	*Cwt.* 21·5 *Bushels.* 39·2
Barley (including Bere) .	*Tons.* 129,000 *Quarters* 683,000	*Tons.* 134,000 *Quarters.* 695,000	151,588	158,657	*Cwt.* 17·1 *Bushels* 36·0	*Cwt.* 16·9 *Bushels* 35·0	*Cwt.* 17·1 *Bushels.* 35·3
Oats ..	*Tons.* 701,000 *Quarters.* 4,858,000	*Tons.* 672,000 *Quarters.* 4,613,000	955,535	968,211	*Cwt.* 14·7 *Bushels* 40·7	*Cwt.* 13·9 *Bushels.* 38·1	*Cwt.* 14·4 *Bushels.* 39·3
Beans ..	*Tons.* 3,500 *Quarters.* 15,600	*Tons.* 3,200 *Quarters.* 14,400	3,732	3,803	*Cwt.* 18·7 *Bushels.* 33·5	*Cwt.* 17·0 *Bushels.* 30·3	*Cwt.* 19·3 *Bushels.* 35·9
Hay from Rotation Grass	*Tons.* 720,000	*Tons.* 657,000	415,322	414,527	*Cwt.* 34·7	*Cwt.* 31·7	*Cwt.* 30·7
Hay from Permanent Grass ..	152,000	139,000	109,703	108,526	27·7	25·6	25·7
Hay from Timothy Meadows ..	102,000	94,000	45,062	44,331	45·3	42·5	41·5
Potatoes	845,000	821,000	138,281	136,976	*Tons.* 6·1	*Tons.* 6·0	*Tons.* 6·6
Turnips and Swedes	6,752,000	6,561,000	405,693	409,642	16·6	16·0	16·5
Mangolds	22,700	25,200	1,316	1,631	17·2	15·4	19·0

The sowing of wheat was carried out under more or less normal conditions. Growth was unusually slow during the spring months, especially on wet land, while the cold, wet and sunless conditions

during July and August delayed the ripening of the grain. Harvest was later than usual, and in most cases the crop was not secured until the latter part of October. The produce of grain has not come up to earlier expectations, but the yield of straw is satisfactory practically everywhere. As a result of the lack of sunshine much of the grain is soft, while some loss occurred in handling owing to the crop being badly lodged by rain and wind storms in August and September. The crop was not affected by disease or insect pests in any district. Barley was sown in good order and made satisfactory progress throughout the season. Ripening was slow, however, while the heavier crops were badly laid in many districts. Generally speaking, however, the ears were well filled and the yield has proved to be fully up to the average. Oats promised to be an unusually good crop, but as in the case of wheat and barley the best fields were laid and twisted by heavy rains before the grain had fully matured. As a consequence harvest was slow and difficult and much grain was lost in handling. The ultimate yield, however, has proved better than was at one time anticipated, and, taking the country as a whole, is above the average for the preceding ten years. Grub was rather prevalent in several districts during the spring and caused considerable damage.

The planting of potatoes was carried out in March and April under excellent conditions, but the completion of operations was interrupted during May owing to unsettled weather. Complaints of disease were fairly general owing to the wet season, the degree to which the tubers were affected depending on the conditions that prevailed locally. The sowing of turnips was retarded during May owing to the difficulty of securing a good seed-bed. In the northern, north-eastern, and east-central districts "finger-and-toe" was rather prevalent owing to the wetness of the soil throughout the season. Turnips have proved an average crop but the yield of mangolds is below the normal.

The total produce of wheat, 49,000 tons, is less than that of last year by 15,000 tons, or 23·4 per cent.; the area under the crop is the smallest recorded since 1908 and is less than that of the previous year by 9340 acres, while the average yield per acre, estimated at 19·8 cwt., is exactly two cwt. less than last year, when the average yield approximated to that of the previous ten years. Barley, with a total produce of 129,000 tons, shows a decrease of 5000 tons, or 3·7 per cent.; the area under the crop shows a diminution of 7069 acres from last year, but the average yield per acre, 17·1 cwt., is greater than last year by 0·2 cwt. and equals the ten years' average. The total produce of oats, 701,000 tons, shows an increase of 29,000 tons, or 4·3 per cent.; the area under the crop is less than last year by 12,676 acres, but the yield per acre, 14·7 cwt., is greater by 0·8 cwt., and is 0·3 cwt. in excess of the decennial average. The produce of beans, 3500 tons, is 300 tons over last years' total. The area under the crop, 3732 acres, shows a slight decrease, while the yield per acre, 18·7 cwt., is 1·7 cwt. greater than the exceedingly low yield of the previous year, but falls short of the ten years' average by 0·6 cwt.

The total produce of hay, taking all kinds together, is 974,000 tons, which is 84,000 tons, or 9·4 per cent., more than last year.

Hay from rotation grass shows a total produce of 720,000 tons, an increase of 63,000 tons, or 9·6 per cent. The yield per acre, 34·7 cwt., is greater than last year by 3·0 cwt., and is 4·0 cwt. above the decennial average. Both the total produce and yield per acre are the largest recorded since 1916. Of other hay, the total production of which is 254,000 tons or 21,000 tons in excess of last year, ordinary meadows yielded 152,000 tons and Timothy meadows 102,000 tons; the former has a yield of 27·7 cwt. per acre or 2·1 cwt. more than in 1923, while the yield per acre of Timothy meadows, 45·3 cwt., shows an increase over last year of 2·8 cwt., and is the highest recorded since separate statistics were obtained in 1913. The average yield of the two together, which is not shown in the table, is 32·8 cwt. or 2·5 cwt. in excess of the ten years' average.

The total produce of potatoes, amounting to 845,000 tons, is greater than that of last year by 24,000 tons, or 2·9 per cent.; the area under the crop, 138,281 acres, shows an increase of 1305 acres, while the yield per acre, 6·1 tons, is 0·1 ton above that of 1923, but is 0·5 ton below the decennial average. Turnips and swedes show an increase of 191,000 tons, or 2·9 per cent., the total produce being 6,752,000 tons. The area is less by 3949 acres, but the yield per acre, 16·6 tons, is greater than last year by 0·6 ton and is 0·1 ton above the average of the ten years. The total produce of mangolds, 22,700 tons, is 2500 tons less than the abnormally small crop of last year. The area, 1316 acres, is the smallest recorded since 1895, while the yield per acre, 17·2 tons, is greater than that of 1923 by 1·8 tons, but is 1·8 tons below the decennial average.

It will be observed that, in comparison with the ten years' average in each case, oats, hay, and turnips and swedes show a higher yield per acre; barley has given an average yield, while wheat, beans, potatoes and mangolds have fallen short of the average.

Deposits of Potash in Spain.

It has been known for some years that important potassic deposits were to be found in Spain, particularly in the region about Manresa in the province of Catalonia. A long and thorough investigation has proved the presence of a great bed at Suria which it is estimated will yield close on 270 million tons of anhydrous potassic oxide. Preparations for the exploitation of this bed are far advanced; a master shaft has been sunk to a depth of 1000 feet, having three levels and 10,000 feet of galleries. Works with all the most recent improvements have been erected for the treatment of the potassic salts on a very large scale. Storage accommodation for 10,000 tons has been provided at the surface so that regularity of production may be assured. A railway has been constructed to link up these works with the main lines passing through Manresa, thus bringing the mines into direct communication with the port of Barcelona.

The potash is found in the form of sylvinite and carnallite, the latter predominating. In the case of the former no treatment is required beyond separating the rock salt, and grinding to the

necessary fineness, in order to produce a potassic manure. From the carnallite is obtained the concentrated muriate by a new chemical process for the elimination of the magnesia, although it has been found that magnesia is not present to any great extent. The potassic manure will be available to farmers in the usual forms of low grade salts, and also the muriate and the sulphate.

It is evident now that Spain at no distant date will enter into the world's markets with a new, and what is believed to be inexhaustible, supply of potash.

An account is given of the Spanish deposits by Don Augustin Martin in the Bulletin of the Geological Institute of Spain, xliv., iv., 3rd Series E.

Guide to Current Official Statistics, Vol. II.

IN the JOURNAL of January 1924 a notice appeared regarding the *Guide to Current Official Statistics*, which dealt with statistical volumes and returns issued in 1922. A second volume of the *Guide* has now been published, dealing mainly with statistics issued in 1923, but including also a number issued in the early months of 1924. The new volume, while issued at the same price as the first one, is considerably larger, containing 306 pages as compared with 162. This increase is partly accounted for by a new feature of great value, viz., a list of Government publications of permanent statistical interest issued mainly between 1900 and 1922. The bulk of the *Guide* has also become greater owing to a large increase in the number of statistical publications issued in 1923 as compared with 1922, and to a number of improvements that have been made as the result of experience in the use of the first volume. The explanatory preface has been made fuller, the system of cross-references has been expanded, and a new key to the statistical contents of particular volumes is given in order to facilitate rapid reference. The continued demand for copies of the first volume is evidence both of an increased public interest in statistics and of the usefulness of the *Guide*. Copies of the new volume may be obtained from H.M. Stationery Office, 120 George Street, Edinburgh, either directly or through any bookseller, price 1s. net, or by post 1s. 4d.

International Year-Book of Agricultural Statistics for 1923.

THE Statistical Year-Book of the International Institute of Agriculture for 1923 has recently been published. As in earlier issues, the statistics given include the total area and population of every country, with subdivision of the territorial area on an agricultural basis; the area and yield of the various crops; international trade, prices and freights; and the production of fertilisers. Tables are also given to show the rates of money exchange over a period of years.

A substantial innovation has been introduced by the compilation of a series of tables showing for each country separately the

utilisation of the land, the apportionment of cultivable area to various crops, the agricultural production and details of live stock. The chapter on trade deals with additional articles of produce, while those on prices and rates of freight have also been enlarged.

The notes and tables are in French and in English, and the volume provides a most comprehensive survey of world agriculture.

Copies of this publication may be purchased from the Ministry of Agriculture and Fisheries, 10 Whitehall Place, London S.W. 1, price 8s.

Acreage under each Variety of Potatoes in 1924.

A STATEMENT is printed at page 113 showing the acreages under certain varieties of potatoes in Scotland in 1924, as returned by growers of one acre and over. These returns cover 120,144 acres out of the total acreage of 138,281, the difference being accounted for by the complete exclusion of certain districts in the Highlands and Western Islands, and by the exclusion of holdings on which less than one acre is grown.

The area under First Earlies, 15,739 acres, shows a decrease as compared with 1923 of 1572 acres or 9 per cent. Epicure, with 8883 acres, is again the outstanding variety, the area grown, although less than last year by 527 acres, comprising more than half the total acreage. Sharpe's Express, with about the same acreage as last year, comes second, while Eclipse and Duke of York (the latter showing a substantial decrease) are almost equal for third place.

Second Earlies also show a decrease, the acreage being 17,584, which is less than last year's by 1482 acres or 8 per cent. Great Scot, with 9128 acres, has decreased by 553 acres, but again accounts for fully half the total. British Queen is second, and Arran Comrade, with a diminution of 27 per cent., is third by a long distance.

The area under Maincrops, 86,821 acres, is greater than that of 1923 by 4096 acres, which counterbalances the decreases in the other groups and leaves a net increase of 1042 acres. Arran Chief is still first with 18,938 acres, in spite of a decrease of 2083 acres, but it is closely followed by King Edward VII. with 18,704 acres, which is 1805 acres more than last year. Arran Chief's lead is thus reduced from 4122 acres to 234. Kerr's Pink, with 17,574 acres, regains the third place, which it held in 1922; the increase this year is no less than 6586 acres. Golden Wonder, with 13,220 acres, falls to the fourth place, although it has increased by 817 acres.

During the six years that have passed since these returns were first obtained in 1918 remarkable changes have taken place in the acreage of certain varieties. Allowance must be made for the fact that the total area included in the returns for 1918 was about 141,000 acres, while this year it is less by nearly 21,000 acres. The general tendency is (except among First Earlies) to substitute varieties immune from wart disease for non-immune varieties. The extent to which this process has gone on during the last six years is shown in the following table.

TABLE I.

		First Earlies.	Second Earlies.	Main-crops.	Total.	Per Cent.
		Acres.	*Acres.*	*Acres.*	*Acres.*	
1918	Immune	200	12,200	15,100	27,500	19·5
	Non-immune ...	12,600	12,200	79,700	104,500	74·2
	Unspecified ...	1,200	2,700	5,000	8,900	6·3
	Total ...	14,000	27,100	99,800	140,900	100·0
1924	Immune	600	11,650	42,850	55,100	45·9
	Non-immune ...	15,050	5,750	43,300	64,100	53·3
	Unspecified ...	100	200	650	950	0·8
	Total ...	15,750	17,600	86,800	120,150	100·0

The changes in the acreage of each immune variety are (in round figures) as follows:—

TABLE II.

Immune Varieties.

Name.	1918.	1924.	Increase or Decrease.
	Acres.	*Acres.*	*Acres.*
Kerr's Pink	300	17,550	+17,250
Golden Wonder	4,150	13,200	+ 9,050
Great Scot	5,250	9,150	+ 3,900
Tinwald Perfection ...	100	1,800	+ 1,700
Majestic	600	2,150	+ 1,550
Crusader*...	...	950	+ 950
Arran Comrade*... ...	...	900	+ 900
Rhoderick Dhu*... ...	...	860	+ 860
Champion...	1,050	1,700	+ 650
Lochar	930	220	− 710
Langworthy	2,550	1,450	− 1,100
Templar	1,270	70	− 1,200
Sutton's Abundance ...	3,150	1,850	− 1,300
Ally	2,800	600	− 2,200
King George V.	4,150	350	− 3,800
Other varieties	1,200	2,300	+ 1,100
Total	27,500	55,100	+27,600

The varieties marked thus * were not separately returned in 1918. Crusader reached 1600 acres in 1922, and Arran Comrade 5600 acres in 1921. Of the others, it may be noted that in 1920 the acreage of Great Scot was 17,000, that of Majestic 3200 and that of Champion 3000, while in 1921 Lochar had 1700 acres and in 1922 Tinwald Perfection had 5100. Of the varieties not given separately in the table, Arran Victory had 1200 acres in 1921, but is this year below 600.

It will be observed that the increase is almost wholly accounted for by Kerr's Pink and Golden Wonder, the net increase of all the other varieties being only 1300 acres.

The corresponding details of the non-immune varieties are as follows:—

TABLE III.

Non-immune Varieties.

Name.	1918.	1924.	Increase or Decrease.
	Acres.	*Acres.*	*Acres.*
King Edward VII. ...	13,750	18,700	+ 4,950
Field-Marshal	...	2,050	+ 2,050
Sharpe's Express... ..	400	2,050	+ 1,650
Duke of York	600	1,700	+ 1,100
Eclipse	1,350	1,750	+ 400
Epicure	9,500	8,900	- 600
Northern Star	1,500	150	- 1,350
Evergood	3,400	200	- 3,200
British Queen	11,850	5,550	- 6,300
Up-to-date .. .	10,550	2,850	- 7,700
President	10,100	350	- 9,750
Arran Chief	40,350	18,950	21,400
Other varieties	1,150	900	- 250
Total	104,500	64,100	- 40,400

Field-Marshal was not returned separately in 1918. King Edward reached 20,300 acres in 1923, but apart from this there are no outstanding features in the intervening years.

Of all the important varieties, immune or non-immune, Epicure shows the most consistent record, with an average for the seven years of 9500 acres, a maximum of 10,300 in 1922 and a minimum of 8900 in the present year.

Among the non-immune varieties Arran Chief accounts for more than half the total decrease. This variety in 1918 covered 28·6 per cent. of the total acreage included in the returns, while this year its proportion is 15·7 per cent.

In each of the two years four varieties covered among them more than half the total acreage as follows:—

TABLE IV.

1918.			1924.		
Name.	Acreage.	Per Cent.	Name.	Acreage.	Per Cent.
Arran Chief ...	40,350	28·6	Arran Chief ...	18,950	15·7
King Edward VII.	13,750	9·7	King Edward VII.	18,700	15·5
British Queen ...	11,850	8·4	Kerr's Pink ...	17,550	14·6
Up-to-Date ...	10,550	7·5	Golden Wonder ...	13,200	11·2
Total	76,500	54·2	Total	68,400	57·0

It will be noted that the four leading varieties are more evenly distributed as regards their proportional acreage in 1924 than in 1918, and that, while in 1918 all four were non-immune, in 1924 two of the four are immune varieties.

Another point of comparison between 1918 and 1924 is the distribution of the total acreage between first early varieties, second earlies and maincrops. In the former year these three groups included respectively 10 per cent., 20 per cent. and 70 per cent. of the total, while this year the proportions are 13 per cent., 15 per cent. and 72 per cent. Thus first earlies and maincrops show a relative increase at the expense of second earlies, first earlies indeed showing an absolute increase. The actual figures are given in Table I. above.

The following notes are added in explanation of the changes recorded above:—

Reduction in second earlies.—A succession of wet autumn seasons, which are unfavourable to second early varieties on account of the ravages of blight, favours the return to the planting of a greater acreage of late or maincrop varieties, which are hardier and more reliable in respect of the production of a healthy crop. The reduction may also be accounted for by the overflow from the first earlies, and by the effects of the increase of foreign competition in first and second earlies.

Great Scot is the most popular in Scotland of the mid-season varieties as a culinary potato for late autumn and early winter. It yields a high ratio of marketable tubers.

Kerr's Pink has increased in popularity on account of its high yielding capacity and its consistent good quality.

Golden Wonder owes its popularity to its good keeping qualities, and to the fact that its excellence as an article of food makes it command a ready sale even in seasons when there is a glut of potatoes.

These three varieties are most in favour with consumers, and consequently are largely planted in the Scottish ware-producing areas.

Tinwald Perfection has lost favour with growers on account of its susceptibility to foliage diseases, and its tendency to produce too great a ratio of small tubers to large, unless in exceptionally favourable circumstances of cultivation. Similar remarks apply to *Crusader* and *Arran Comrade.* The eclipse of the latter was completed by its susceptibility to blight. *Majestic* is not favoured in Scotland as a table potato, but it has found a place in England as a profitable mid-season variety; English demands for seed largely enable it to maintain a notable place in Scottish cultivation.

Lochar has never been able to take an important place among potato varieties. This is largely due to its susceptibility to foliage disease and its lack of quality. The latter disability has also rendered *Templar*, *Ally* and *King George V.* unpopular.

The place of *Abundance*, which was revived on account of its immunity from wart disease, has been taken by *Great Scot.*

The dark blue colour of *Arran Victory* has been a bar to its extended cultivation.

King Edward VII.—The increased acreage under this variety is entirely due to its increased popularity in England, where there is a ready market both for Scottish seed and for Scottish ware. Scottish-grown King Edward VII. is only of very moderate boiling quality, but is suitable for chipping. Consequently good-sized ware potatoes of this variety always have a ready sale.

Field Marshal is the modern representative of Up-to-Date, and the decrease in the area under the latter is partly balanced by an increase of the area occupied by this attractive russet variety.

Arran Chief owes its large acreage to its good quality, consistent cropping, resistance to blight and good cover. The reduction in acreage is due to its susceptibility to wart disease and to the spread of foliage diseases in the stocks.

The bulk of the produce of early varieties, the most popular representatives of which are Sharpe's Express, Duke of York, Eclipse and Epicure, is—with the exception of the major portion of the Epicure crop and a small portion of the crop of Duke of York—designed for the English seed market. The increased acreage under these varieties is perhaps a reflection of the extension of the allotment movement and the increased demand for Scottish seed.

Epicure is the staple first early crop in Scotland, and as the area planted on the Ayrshire coast is actually the same ground year by year, the acreage of this variety tends to remain steady.

British Queen is being replaced by Great Scot in Scotland and by Majestic in England.

Evergood is grown only as a seed crop in Scotland, where it is restricted to a small area near the course of the river Tay. The decreased acreage is accounted for by the displacement of this variety in England by King Edward VII. and Majestic.

President has lost ground on account of the tendency of stocks to contract degenerative foliage diseases, and on account of its susceptibility to wart disease.

Northern Star is a potato of poor culinary quality; it never had a vogue except in East Fife, and appears to be completely losing favour.

Agricultural Returns for Scotland, 1924.

THE Abstract of the Agricultural Returns, printed on pp. 114-121, shows that the total area under crops and grass amounts to 4,715,290 acres, a decrease of 9148 acres as compared with 1923, the arable land having decreased by 25,026 acres, while the area under permanent grass is greater by 15,878 acres. The land under rye-grass and other rotation grasses and clover has increased by 9494 acres, the decrease in the area under other crops being thus 34,520 acres. This decrease is spread over the majority of the crops, potatoes being the only important excep-

tion. The cereal crops show a total area of 1,164,540 acres, or 28,760 acres less than last year. The area under wheat, which is the smallest recorded since 1908, shows a diminution of 9340 acres or 15·9 per cent. Barley has decreased by 7069 acres or 4·5 per cent., the acreage being the lowest recorded since 1915. Oats show a decrease of 12,676 acres or 1·3 per cent., the area being the smallest since 1914. Beans show a slight decrease in acreage, but potatoes increased by 1305 acres or nearly 1·0 per cent., while the area under turnips is less by 3949 acres or 1·0 per cent. The area under mangolds, 1316 acres, is 315 acres less than last year and is the lowest recorded since 1895. Rape shows a decrease of 2499 acres or 17·4 per cent. The area under vetches, tares, etc., for fodder is greater by 420 acres or 4·1 per cent. Carrots are practically unchanged in area, while cabbage, with 4139 acres, is less by 139 acres or 3·2 per cent. The area under flax shows a considerable decrease, the acreage being 126 as compared with 607 last year. The net increase in the area under rotation grasses and clover is 9494 acres or 0·6 per cent., the area for hay having increased by 795 acres and that for pasture by 8699 acres. The area under permanent grass is greater by 15,878 acres or 1·1 per cent., the area for hay showing an increase of 1908 acres and that for pasture an increase of 13,970 acres. The total area cut for hay was 570,087 acres, or 2703 acres more than last year.

The area under wheat, barley, oats and potatoes this year is, in round figures, 1,295,000 acres, which is 28,000 acres less than last year and is the lowest aggregate recorded since the statistics were first collected.

The live stock returns show that the numbers of sheep and pigs have increased, while horses and cattle are less numerous. The decrease in horses is, as last year, most noticeable in the "unbroken" classes, which show a total diminution of 8710, of which 6821 are "one year and above" and 1889 are "under one year." Horses used for agricultural purposes have decreased by 1543, while "other horses" are more numerous by 116, the net decrease thus being 10,137 or 5·0 per cent. Cows in milk have decreased by 9486 or 2·6 per cent., while cows in calf have increased by 4307 or 10·2 per cent.; heifers in calf, however, show a decrease of 1796 or 3·5 per cent. Bulls used for service show a slight increase, but other cattle of all classes have decreased, the numbers of those of two years and above being less by 10,845 or 4·8 per cent., those of one year and under two by 1947 or 0·7 per cent., and those under one year by 9475 or 4·1 per cent. The total number of cattle has thus decreased by 29,193 or 2·4 per cent. Sheep are more numerous than in 1923, the total being higher by 100,429 or 1·5 per cent. Breeding ewes have increased by 88,806 or 3·1 per cent., rams by 4106 or 5·1 per cent., and lambs by 22,686 or 0·8 per cent., while other sheep of one year and above are numerically less by 15,169 or 1·5 per cent. The net increase in the number of pigs amounts to 12,809 or 6·9 per cent. The number of sows has decreased by 471 or 1·9 per cent., while boars have increased by 96 or 3·7 per cent., and other pigs by 13,184 or 8·3 per cent.

The returns collected this year include statistics of the acreage owned by the occupiers of the holdings and particulars relating to labour. These figures are not included in the printed abstract.

The total area of land under crops and grass owned by occupiers of holdings this year amounts to 989,700 acres as compared with 883,558 acres in 1923, showing an increase of 106,142 acres

Labour employed on holdings (exclusive of the occupiers, their wives and domestic servants) totalled 117,342 as compared with 120,024 last year, a decrease of 2682 or 2·2 per cent. Of these, 100,185 were returned as regular workers and 17,157 as casual workers Regular workers comprised 80,087 males and 20,098 women and girls, while casual workers were made up of 8759 males and 8398 women and girls.

Agricultural Conditions in 1924.

Weather.—The weather during January 1924 was mainly wet and dull, but was somewhat milder than during the last two months of 1923. The conditions during February, March and April were cold and unusually dry, the rainfall during March being only 40 per cent. of the normal and in February 60 per cent. Falls of snow were fairly general during the last week of February and the first fortnight of March. The weather during May and June was unseasonable and was rather unfavourable for agriculture; rain was frequent and heavy, especially in May, while during both months the amount of sunshine was below the normal. The weather continued rather cold, wet and sunless during July and August; as a result, the grain crops ripened slowly, while in many districts the heavier crops were badly lodged by the persistent rains, which also retarded the cutting and ingathering of the hay harvest. The rainfall during September was unusually heavy in many districts, but at intervals there were some bright days with drying winds which enabled a portion of the cut crops to be secured. Speaking generally, however, harvesting was difficult and slow owing to the lodged and twisted state of the crops; in several districts considerable areas could be cut only by scythe. During October the weather was variable, but on the whole was fairly favourable for the completion of harvest operations.

Wheat.—The sowing of wheat was carried out under more or less normal conditions. During the spring months growth was rather slow, especially on stiff soils, while the cold, wet and sunless conditions during July and August delayed ripening. As a result of the lack of sunshine much of the grain is soft, and in most districts the yield has not come up to earlier expectations. There was also considerable wastage of grain in handling owing to the crop being badly lodged by rain and wind in August and September. The crop was not affected by disease or insect pests in any district, but the effect of the adverse climatic conditions is shown in the yield per acre, which is estimated at 19·8 cwt. or 2 cwt. less than last year.

Barley.—Barley was sown in good order and made satisfactory progress throughout the season. The wet conditions favoured the growth of straw, but the grain was slow in maturing. The heavier crops in many cases were badly laid by the persistent rains during the summer months. Generally speaking, however, the ears were well filled and the ultimate yield has proved to be fully up to the average. In Orkney, Shetland and the western islands the yield and quality of the bere crop are reported to be satisfactory. In no district was the barley crop affected by disease or insect pests.

Oats.—Oats promised to be an unusually good crop, but as in the case of wheat and barley, considerable areas of the best fields were laid and twisted by heavy rains before the grain had fully matured. Harvest was slow and difficult and much grain was lost in handling, while in several districts wastage also occurred owing to long exposure in the stook. The yield, however, has proved better than was anticipated, and, taking the country as a whole, is higher than last year, and is also slightly above the average for the preceding ten years. Straw was a bulky crop, but in many cases it is of inferior quality. Grub was rather prevalent in several districts during the summer months.

Beans.—The season was on the whole fairly favourable for beans. The pods were plentiful but the beans did not ripen satisfactorily, and the yield ultimately proved to be smaller than was expected earlier in the season. The crop was barely up to the average as regards quality, while the yield, although higher than last year, was below the average for the preceding ten years. The straw was of a good length practically everywhere.

Potatoes.—Potatoes were planted during March and April under excellent conditions, but in May operations were interrupted more or less owing to the unsettled weather. The reports regarding the yield show much variation. On light soils the crop is exceptionally good, notwithstanding the wet season and lack of sunshine, but on heavy land the haulms died down early and rapidly and the tubers were rather undersized. The yield per acre for Scotland as a whole is rather below the average for the preceding ten years, although slightly above that in 1923. Complaints of disease were fairly general, and the keeping qualities of the crop are stated to be rather uncertain in some cases.

Turnips.—Turnips and swedes brairded well and during the early summer growth was healthy and vigorous. Later, however, the excessively wet conditions and the lack of sunshine were against progress, and as a result the yield on stiff soils has not come up to earlier expectations. On light soils, however, and where free from disease, the crop has yielded satisfactorily and the produce per acre for the country as a whole is fully up to the average. "Finger-and-toe" was rather prevalent, especially in the northern, north-eastern and east-central counties.

Mangolds.—The persistent rains and lack of warmth during the summer had a detrimental effect on the development of the bulbs, and in most districts in which the crop is grown the yield was substantially below the average. The estimated yield per acre is 1·8 ton higher than last year, but is 1·8 ton below the decennial average.

"*Seeds*" *Hay*.—During the spring and early summer "seeds" hay made excellent progress, but the crop was slow in maturing owing to the sunless conditions. The securing of the crop was difficult and protracted and in many cases the hay deteriorated in quality owing to exposure. On the whole, however, "seeds" hay suffered less than other crops from the unseasonable conditions, and in most cases the yield was well above the average.

Meadow Hay.—The reports on meadow hay are, in general, very similar to those regarding "seeds" hay. Growth was vigorous throughout the season and the produce of the crop was above the normal. Harvesting, however, was difficult owing to the unsettled weather, while much of the grass was soft and rather deficient in feeding value.

Autumn Cultivation.—The mild and open weather during November was favourable for outdoor work. Ploughing proceeded uninterruptedly during the month and the arrears of cultivation due to the late harvest were materially reduced. In some cases, however, operations fell into arrear owing to the soft condition of the ground. Wheat sowing was completed or practically completed at the end of November in east and central Perth, south-west Fife, Lanark and Renfrew, while in most of the other districts in which the crop is principally grown a good breadth of wheat had been got in.

Live Stock.—Feeding cattle are generally reported to be in good condition. Winter keep promises to be sufficient in the great majority of the districts for the requirements of a normal season; straw is plentiful practically everywhere, but in a few districts turnips are rather scarce. Dairy cows are in average condition. and only in one or two districts is the milk yield reported to be lower than is usual at the winter period. Sheep of all classes, both on arable and on hill farms, improved greatly in condition during the autumn months.

Labour.—The latest reports regarding labour are generally to the effect that the supply of regular workers is plentiful except in Kincardine, north-east Forfar and north and east Perth. Experienced dairyworkers are short of requirements in Renfrew and to a lesser extent in north Ayr.

RECENT PERIODICAL LITERATURE.

A number of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins and to the original publications quoted therein may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

Field and Pot Experiments in Electro-Culture. *I.—Blackman, V. H., Journal of Agricultural Science, Vol. XIV., Part 2. Cambridge*, 1924. *II.—Blackman, V. H., and Legg, A. T., Pot-Culture Experiments with an Electric Discharge, Ibid.*—I. The author gives a brief account of the history of electro-culture from the time of the first experiments carried out by Mambray at Edinburgh in 1746 to the present day.

Details of the field experiments carried out on cereals and clover from 1915 to 1920 are given.

The discharge was usually given at the rate of 0·5 to 1·0 milliamp. per acre from thin wires stretched above the crop at a height of about 7 ft. and charged to a voltage of 40,000 to 80,000. The discharge was usually given for 6 hours a day in two periods of 3 hours in the morning and 3 in the afternoon.

Of 18 experiments with various crops, 14 gave positive results in favour of the electrified plots and 4 gave negative results. The positive results showed increases of from 3 to over 30 per cent. With spring-sown cereals 6 results are recorded of increases of 30 to 57 per cent., whereas the two negative results are only 6 and 9 per cent.

It is improbable that the mean increase yield of 22 per cent. is the limit that may be obtained with spring-sown cereals.

In several cases the electrified field-crops showed a deeper tint than that of the controls. The effect of the discharge is in the nature of a stimulus, as the additional available energy from the current is too small to have any direct effect. There is no evidence that gaseous products of the discharge play any part in the stimulation of growth.

II. The previous paper deals with the results of field-experiments, in which, although the increased yields were very definite, the probable error may be large, and the authors recognised the necessity of carrying out experiments to study the effect of varying conditions. Owing to the large number of factors involved the time occupied by field-experiments would be great, whereas in pot-culture experiments the probable error can be reduced to 2-3 per cent., and significant results can be obtained in a single year; hence the decision to adopt this method of investigation. The experiments ran concurrently with those in the field, and were carried out at the Rothamsted Experimental Station from 1918 onwards.

A summary of the results obtained is as follows:—The experiments carried out over a period of four years with wheat, barley and maize show that these plants show increase in dry weight when subjected to minute electric currents from wire network charged to a high voltage suspended above them.

Maize plants grown under glass showed an average percentage increase in dry weight of 27, and barley of 18.

Increased growth was obtained with both direct and alternating current, the latter being as effective or even more so than direct.

Electrification of barley for the first month of the growing season appears to be as effective as electrification during the whole growing season.

The discharging net-works were usually charged *positively*, but a similar stimulating effect on dry weight production was obtained with a negative charge.

Currents of the order of 1×10^{-8} amp. per plant and higher are injurious, and cause reduction of dry weight.

The pot-culture experiments are in conformity with those from the field and the laboratory, and leave no uncertainty as to the favourable action of the electric discharge.

Electrocultural Experiments in Italy. *Munerati, O. Nuovi Annali dell' Agricoltura, Year IV., No.* 1. *Rome,* 1924.—By means of the Paulin antennæ method, the author electrified the sugar-beets growing on a plot of 185 m. × 46 m. and found as a result of careful experiment that these roots had a higher average weight and mean saccharose content than the sugar-beets cultivated on the control plots. The increases were greater in plots with underground wires (average weight 261 gm., mean saccharose percentage 14·38 per cent., as against 223 gm. and 14·01 per cent. for the check plot) than in the plots with overhead wires (237 gm., 14·71 per cent. saccharose as against 235 gm. and 14·15 per cent. for the check plots). The author does not, however, consider these experiments conclusive and intends continuing them.

The Correlation between the type of Horse and its Speed. *Prawochenski, B. Revue de zootechnie, la revue des éleveurs, Year* 3, *No.* 5. *Paris,* 1924. —The effect produced upon the type of horse by racing is a much debated question among judges of horses in all countries. It has even been stated that the alterations produced in the English race-horses re-appear in their descendants with the result that the animals are deficient in flesh.

Dr Stratul, after studying the measurements of fast and of slow thoroughbreds and also of American trotters, has come to the conclusion that very swift

horses are more regular in conformation and have a larger circumference of chest than others. Some investigators, on the other hand, are inclined to regard the light, spare build to be more conducive to speed than a large, heavy build.

The author, who has had the opportunity of measuring many Russian trotters, approached the problem from the biometric standpoint and solved it by accurate and incontestable calculations. As the animals were registered officially, he was able to calculate the *coefficient of correlation* (Pearson's method applied by Davenport) between the weight of the animals and their speed. In order that the height factor should not obscure the problem, he determined for each individual the *index of compactness* by dividing the weight in kg. by the height at the withers in cm. The various data show that the positive correlation existing between the speed and the weight of trotters is too slight to allow that weight should be regarded as a factor favourable to speed, but at the same time it proves clearly that no antagonism exists between weight and speed. The greater compactness of the swifter horses is probably explained by the necessity that they should possess more solid limbs, a broad chest and strong muscles.

The author has also tried to prove that the volume of horses is in correlation with their origin. He divides them into 4 classes according to their place of origin and states that the volume of the horses varies according to the region. The *mean index of compactness* for each region works out as follows:—2·82 for the first (black soils rich in lime); 2·77 for the second (Ukrainia, soil rich in humus but with lower lime content); 2·70 for the third (clay or sandy soil and marshes); and 2·58 for the fourth, which has the same characters. It may, therefore, be concluded logically that the chief factor which determines variations in the compactness of the horse are to be found in the soil, and consequently in the grazing-ground. The author obtained the same results from an examination of the correlation between selection based on speed, the volume of the horses and the size of their limbs. Selection based on speed only gave secondary results as compared with the effect of the system of breeding and also the quality of the pastures and the food given to the foals. Selection for speed is not without its effect upon the type; it tends to remove superfluous weight in swift horses. It cannot, however, be said that the swiftest horses have the longest legs. The elongated skeleton and relatively long legs found in many swift racers are due to their abnormal conditions of rearing, for they are kept in a stable or a small field and supplied with food rich in albuminoids and poor in lime.

The Artificial Fertilisation of Mammals and Birds. *Iwanow, E. Comptes rendus de l'Académie des Sciences, Vol.* 178, *No.* 22. *Paris*, 1924.—The author has made use of artificial fertilisation in the hybridisation of certain animals, *e.g.*, in crossing the horse with the zebra and *Equus Prjevalsky*, and in his experiment on the fertility of hybrids resulting from crosses between *Bison americanus* and *Bison bonasus* and horned cattle (*Bos taurus*). Artificial fertilisation has practical advantages as a remedy against sterility, and of largely increasing the number of females that can be fertilised by a single male. It has been practised in service and stud stations in Russia since 1909.

Since this date no fewer than 8000 mares have been fertilised artificially, while artificial fertilisation has been adopted with conspicuous success in the case of cows, sheep and sows, as well as in breeding mules and large donkeys, and on fur-farms where black and silver foxes are reared.

Loss of Weight in Animals during Transport. *Dechambre, P., Revue de zootechnie, la revue des éleveurs, Year* 3, *No.* 5. *Paris*, 1924.—Animals that travel, whether on foot or by rail, suffer loss of weight to a greater or less degree owing principally to the decrease in the content of the digestive tube, which gradually becomes empty.

The live-weight is the first to be affected, at any rate in ordinary journeys of average length or short duration, little difference being noticeable in the net weight. If, however, the animals have to make a long or trying journey, the loss in net weight is very marked. The evacuation of the food and liquids which causes the fall in weight takes place chiefly on the first day, excretion being much diminished subsequently. An ox of 600 kg. will lose 30-40 kg. the

first day and 5·7 kg. on subsequent days. This latter decrease is due to some extent to an interstitial reabsorption which takes place within the tissues, and it allows the fall in net weight to be estimated, for although at first this is little noticeable, it continues to increase with the length of the journey, especially if the animals are supplied with insufficient food and water.

In the course of the first 24 hours, the loss that occurs varies greatly according to the kind of animal, the breed to which it belongs, the distance travelled and the kind of transport. Cattle carried by rail lose on an average 25 to 50 kg. in weight according to their size, but this average may be greatly exceeded. A lot of cattle weighed at a fair were found to have lost in the course of their transport to the abattoir 9·7 per cent. of their weight, whereas another lot that had been driven in straight from the pasture showed a loss of 13·1 per cent. These losses affect the net meat yield, the percentage of which is higher the greater the reduction of the animal.

A sheep weighing 40 to 50 kg. may lose 3 to 4 kg., and a calf of 150 kg. loses about 4 kg. the first day and 2 kg. the second. A pig of 100-110 kg. loses 5 to 6 kg. The loss of flesh is frequently *nil*, unless the distance is very long, the pigs extremely fat and the journey made in great heat, in which cases an elastic litter that absorbs much moisture should be employed.

The question has arisen how far the fatigue, and even the suffering, endured by the animals in course of transport may alter the quality of their meat. It should be remarked, in the first place, that there is a certain amount of mortality amongst all kinds of animals when travelling. This is especially the case with swine on account of their particular anatomical and physical characteristics, such as skin that acts badly, layer of fat, small mouth opening, and narrow nostrils. The phenomenon known as fatigue-fever is caused by the accumulation within the organism of waste products such as creatin, creatinine, urea, etc. that cannot be eliminated. After the animal is slaughtered, these substances come into contact with the air, putrefaction sets in and causes the rapid deterioration of the meat. It is most important on a journey of some length to see that the animals are provided with drinking water at very short intervals.

A steer that travelled 5 km. on foot and weighed 782 kg. at starting, only weighed 740 kg. on arrival; it finished 426 kg. of net meat, so that its dressing-yield, which should have been 54·4 per cent., was 57·4 per cent.

Many observations show that in the course of transport large losses in weight occur, the live-weight being first reduced through the evacuation of the contents of the digestive tube, and that these losses are able to affect the quantitative and qualitative yield of all butchers' animals.

The Selection of Cattle and the Proportion of the Three Categories in Net Meat. *Berge, R., Comptes rendus de l'Académie d'Agriculture de France, Vol. X., No.* 11. *Paris,* 1924.—The following statements are taken from a work by MM. Laplaud and Degois.

Hitherto, the principles by which the breeder has been guided in meat production may be summarized as follows. It is necessary not only to seek to obtain the largest amount of net meat, but also the largest possible development of those parts where the meat is of the best quality; moreover, the more these parts are developed, the smaller will be the meat of the third class. The authors, on the other hand, concluded from the results of experiments that the proportion of meat of first quality is nearly constant in net meat and that the question of race is of little importance in this connection.

"The improvement of beef breeds does not consist in the improbable increase of the prime cuts, but selection should aim at obtaining earlier maturity, better assimilation, aptitude for fattening and good conformation which help to improve the appearance, grain, tenderness and flavour of the meat, as well as the meat yield."

Natural or Artificial Rearing of Sucking Pigs. *Laplaud, M., and Degeois, E., Revue de zootechnie, la revue des éleveurs, Year* 3, *No.* 5. *Paris,* 1924.—In order to insure that the sow rears her young satisfactorily, it is necessary, as soon as she begins suckling, to determine her nursing capacity and decide how many piglings shall be left to her to bring up. The nursing quality of a sow is frequently estimated from the number of her teats; an

animal with 14 teats being considered a better nurse that one possessing only 10 or 12. This is, however, a mistake, for there is no proof that the total quantity of milk obtained from 14 teats is greater than that drawn from 10. Thus it seems reasonable to suppose that the number of teats is not the chief element upon which to reckon the nursing capacity of a sow. The best criterion is afforded by an examination of the teats themselves. A firm udder with turgescent teats is a good index of milk production. If the brood-sow retains its general good health after farrowing and does not lose flesh or suffer in any way during the nursing period, it is a good indication that the animal has a plentiful milk supply.

The number of piglings to be left with the sow depends upon the number of teats, the animals' nursing capacity, and especially upon the economic object in view, whether the rearing of a number of animals of average quality, or the selection of breeding-stock. Many breeders leave selection to take place naturally, reckoning that the inferior products will succumb. This is not, however, a satisfactory solution of the problem, because the best animals are thereby deprived of the food that would contribute to their full development and render them resistant to disease. It is evident that the best plan is to weed out the most puny piglings. The authors classified the piglings of sows according to their weight at birth and at the end of each month. With few exceptions, all the piglings remained in the class to which they had been assigned at birth. It is thus certain that, as a rule, the young pigs with the best future before them are those which weigh most when they are born, and this fact can be taken as a sure basis for selection.

Artificial rearing.—A sucking-pig taken from the mother can be easily reared on cow's milk, although the milk of the cow contains less fat and albuminoid substances than sow's milk. The pigling soon becomes used to the new food and grows well. Artificial rearing is often necessary in the case of pigs, either because there are not enough teats for all the farrow, or because the sow is a bad nurse, or suffers from mammitis. If the piglings are too many, some of them must be entirely bottle-fed; if the sow is a bad nurse, either all the smallest piglings can be left with her, a bottle being used to supply any deficiencies, or else half the litter can be left with the dam, while the other half can be reared artificially. It must be borne in mind that colostrum has special physiological properties, so that it prepares the digestive tube for the reception or solid food; for this reason, it is well to leave the piglings with their mother for 2 or 3 days. For the first fortnight, young pigs can only suck, so a feeding-bottle is indespensable for artificial rearing. The best food for the young animal is unboiled tepid milk at the temperature it leaves the teat. Boiled milk should only be used if the presence of any pathogenetic micro-organism is suspected. Ordinary milk gives good results and therefore it need not be enriched by the addition of albuminoids or lactose. The piglings should be given a bottle at least 4 or 5 times daily. After the second week, the milk can be put into a dish, for the piglets soon learn to drink. At the end of the first month, some easily digested foods may be added to the ration; barley meal or manioc flour, and mashed potatoes, the amount fed being gradually increased until at last the stage of concentrates (cake) is reached. Then the whole milk can be replaced by skim milk, and later, the piglings are weaned. The essential thing is to proceed slowly and regularly, always keeping in mind the fact that cow's milk has a lower digestibility coefficient than sow's milk and that this difference has an effect upon the assimilation of the foods consumed at the same time. The authors give various instances of artificial rearing and a comparison between the piglings of the same farrow, some of which were suckled by their mother, while the others were bottle-fed. The conclusion reached by the authors was that artificial rearing is often necessary, but can only be regarded at best as a make-shift. Certainly, piglings thrive best on their mother's milk, though if necessity arises, recourse can be had without fear to artificial rearing which, if carried out properly, will insure normal growth.

The Effect of Dairy Operations upon the Cream on the Surface of Milk. *Martin, W. H., and Combs, W. B., Journal of Dairy Science, Vol. VII., No. 2. Baltimore,* 1924.—The consumer often judges of the richness of milk from the amount of cream that rises to the surface of the bottle, but unfortunately this affords no evidence of the fat content of the milk, for the layer of cream is

often reduced in thickness by the transport of the milk to the dairy and the operations to which the milk is subjected. A study of the effect of these various operations upon the cream rising to the surface of milk has been made at the Pennsylvania State College Creamery. The factors studied were: clarifying, pumping cold and hot milk, shaking hot milk, various methods of heating and cooling pasteurised milk.

The capacity of milk for producing cream was estimated by taking samples of milk before and after each operation; these samples were placed in graduated cylinders, so that the cream percentage could be read off at once. The cylinders were kept at the temperature of melting ice and readings were taken every hour during the 24 hours.

Milk at 55° F. and 90 F. on being treated in the De Laval centrifugal clarifier showed little tendency to cream production. No decrease was noted if the milk was heated to 90° F after clarification.

Pumping cold milk does not cause it to lose its creaming power and the diminution is very slight if the milk is pumped when it is hot.

With a view to determining the effect of pasteurisation and cooling upon the creaming of milk, the following experiments were made. After pasteurisation, some of the milk was left in the basin to cool while the remainder was rapidly cooled by passing over a surface refrigerator immediately after it had been heated. Various types of pasteurisers were also tested. It was discovered that, as compared with the volume of cream rising to the surface of raw milk, there was a loss of 30-35 per cent. and 60 per cent. in milk that had been pasteurised and cooled in a receptacle with glass walls; the loss was reduced to 7·8 per cent. and 15 per cent. if the cooling had been effected by means of a surface refrigerator and immediately after the heating. The loss was 8·17 per cent. and 15 per cent. in the case of milk pasteurised and cooled in a pasteuriser with serpentine cooler, but the loss in the same milk cooled on the refrigerator fell to 3 per cent. or 7 per cent. A similar experiment once registered a gain of 8 per cent. It must therefore be concluded that milk cooled in a pasteuriser loses much of its creaming capacity, but the extent of the loss depends on the type of pasteuriser used and how much the milk is shaken. Hot milk when shaken gradually loses its power of creaming; the loss is slight during the first two hours, but subsequently rises to 25-65 per cent. The only means of preventing this loss of creaming is to cool the milk as rapidly as possible and with the minimum amount of shaking. The partial failure of milk to cream is generally attributed to a mechanical cause, a kind of division by shock of the fat globules. The following experiment was conducted with the object of testing this theory. Some whole milk was skimmed, and both the cream and the skim milk were shaken for several hours. Then the cream and the milk were mixed together. It was found that the shaking had little effect on the cream, but the layer of cream that rose to the surface of the reconstituted milk was much thinner than it would have been normally. The chief cause of the variation in the amount of cream rising to the surface of milk is an alteration in the whey, but not in the butter-fat of milk.

The Value of the Results Obtained from Milk Testing. *Berge, R., Comptes rendus de l'Académie d'Agriculture de France, Vol. I., No.* 16. *Paris,* 1924.—Owing to the influence brought to bear by the "Offices agricoles," many Milk Testing Associations have recently been formed in France. It is therefore a matter of considerable interest to ascertain the degree of accuracy obtained according as the tests are carried out at longer or shorter intervals. This study was made by MM. Laplaud, De la Frégonnière and Duffau at the National Centre of Stock-Breeding Experiments at Vaulx-de-Cernay.

If each cow is considered separately, the errors in testing the amount of the milk yield do not increase in proportion to the length of time elapsing between the tests, but if the average results obtained from a group of 10 cows are taken, it is seen that the errors in the case of tests carried out weekly—fortnightly—every three weeks—every month, are respectively 1·04—1·48—2·08—2·68 as compared with the errors made in daily testing.

The same is true of the testing of the butter-fat.

Two sources of error, which are as important as periodicity, are incomplete milking and weighing. The amount of error due to the first is unknown; the error in weighing with the instruments usually employed is from 1 to 2 per cent.

A third source of error may also be mentioned, viz., the possible incorrect reading of the graduated tube by the tester.

These observations show that daily tests of milk and of butter-fat yield may not prove more accurate than periodic tests.

Experiments in Milking Cows by Machinery. *Berge, R., Comptes rendus de l'Académie d'Agriculture de France, Vol. X., No.* 11. *Paris*, 1924.—The Alfa Laval milking machine was tested on 16 cows at Vaulx-de-Cernay. The results obtained formed the subject of a paper written by M. de Rothschild and laid before the "Académie" by the author.

None of the cows objected to the machine; 11 allowed themselves to be thoroughly milked; 5 kept back their milk either partially or entirely. In the case of the first 11 cows, 4·58 per cent. of the total amount of the milk in the udder was drawn by hand-stripping in the morning and 5·58 per cent. in the evening. This milk contained 2 to 6 times more fat than the milk obtained by means of the machine. Machine milking, if the time required for hand-stripping, afterwards is added, takes twice as long as milking entirely by hand. A cow-keeper can easily supervise 4 machines; changing the cow, hand stripping. weighing the milk and pouring it into other receptacles takes only 3 minutes. By machine milking followed by hand-stripping, a little more milk is obtained than if the whole operation were carried out by hand.

Variations in Milk Yield and Percentage of Fat according to the Different Quarters of the Cow's Udder. *Fitch, J. B., and Copeland, L., Journal of Dairy Science, Vol. VII., No.* 2. *Baltimore*, 1924.—The data relating to milk secretion, and especially to the variations in the butter-fat, are becoming of ever-increasing importance for cattle breeders. A first experiment on this subject showed that with a large number of cows there is no appreciable difference in the fat percentage of milk drawn from the several quarters of the udder. An experiment was carried out by the authors at Kansas Agricultural College on 2 Holstein and 3 Jersey cows which lasted two days, or for 4 milkings. The milk from each quarter was drawn separately and the milk was also collected, weighed, sampled and analysed separately. A fortnight later, the same experiment was repeated with the object of verifying the results and to test the permanence of the variations recorded on the first occasion. The data collected show that the results obtained from the two experiments agree very closely. In the case of any given cow the milk from one quarter may always be more plentiful or contain more butter-fat than that of any of the others. Thus, for instance, the front right quarter of cow No. 5 yielded less milk than the other quarters. If, however, the average of all the cows is taken, it is found that no quarter is conspicuously superior to the others from the point of view of milk yield or butter-fat percentage. The right hind quarter of cow No. 1 gave a richer milk than the other quarters in 6 out of 8 estimates, and at the same time yielded a large quantity.

In conclusion, since more constant results are obtained from the estimation of the butter-fat in the milk from the different quarters than by determining the milk yield itself, it may be concluded that quarters with a low milk yield also produce little butter-fat.

Effect of Subcutaneous Injections of Lactose upon Milk Production in Cows. *Campus, A., La Nuova Veterinaria, Year II., No.* 5. *Bologna*, 1924.—The author studies the influence of subcutaneous lactose injections upon milk secretion using two Schwyz cows in his experiments. The animals were milked three times a day, always at the same hours and by the same person. The milk of each milking was very carefully weighed. The cows had a liberal supply of good quality hay always at their disposal.

Cow No. 1.—Had calved three months previously, was in excellent condition, weighed about 650 kg. Age 8 years. The experiment was divided into 3 periods. The first preliminary period lasted from February 9th to 28th and was divided into two periods of ten days. The milk yield showed a natural and progressive tendency to decrease. In the course of the first ten-day period the average daily production was 11·823 kg., but fell to 11·353 kg. during the second period.

The second experimental period (March 1st to 30th) was divided into three ten-day periods; 5 cc. of 5 per cent. lactose were injected subcutaneously every day. A large increase in the milk yield was observed as compared with the milk produced during the last corresponding period in February. The daily increase was 595 gm. during the first period, 557 gm. during the second and 752 gm. during the third, *i.e.* an average daily increase of 645 gm. of milk for the whole month.

During the third period from March 30th, the injections were suspended for 10 days and the milk yield was found to decrease greatly; during the third 10 days of March, the average daily milk production was 12·135 kg., and fell during the present period to 10·958 kg., *i.e.* the average daily decrease was 1177 gm.

From 10th to 19th April the injections were resumed with the result that the average daily milk yield rose 1175 gm.

From 20th to 29th April the injections were again suspended, the average daily milk production falling from 12·13 kg. (4th period) to 11·766 kg., thus showing an average daily decrease of 365 gm.

Cow No 2 – Calved for first time 4 months previously. Age 3 years and average weight 390 kg. During the 20 days of the preliminary period, a slight fall in the milk secretion was noticed, viz., 17·593 litres for first period and 7·395 kg. for the second. The cow was given subcutaneous injections of 5 cc. 5 per cent. lactose for 10 consecutive days, which caused the average daily production to rise from 7·395 kg. to 7·555 kg. or an increase of 360 gm. per day. No injections were given for three periods and the fall in the average daily milk yield was 228 gm. in the first decade, 1·238 kg. in the second, and 1·028 kg. in the third. On resuming the injections for two periods, increase in the daily milk production was found to be 573 gm. during the first period and 675 gm. in the second as compared with the third period without injections.

The injection of 5 cc. of 5 per cent. solution of lactose certainly causes an increase in lactic secretion. The favourable effect of the injection shows itself after the first day, and is maintained throughout the time of the lactose injection, however long it may last, and ceases as soon as the injections are stopped, to manifest itself once more as soon as they are resumed.

From various estimations of the nitrogen and fat content of the milk it was found that there is no perceptible change in the amount, either during the normal period or when the cows are given subcutaneous injections of lactose.

France: Suppression of fraud in the Trade in Milk and Milk Products. —For this purpose the decree of the 25th of March 1924 was issued, which contains administrative regulations for the application of the law of the 1st of August 1905 concerning the suppression of fraud in regard to milk and milk products. This follows a series of decrees all issued with the object of defining in the interest of honest trade and public hygiene the conditions under which different victuals and beverages should be sold.

When the term *milk* is used cow's milk is intended; other types of milk must be specifically described. Milk is unfit for the use of man when taken from diseased cattle; the diseases will be specified in an order (arrêté) issued by the Ministry of Agriculture on the advice of the Consultative Committee on Cattle distempers; artificially coloured, unclean, or foul smelling milk taken from a cow earlier than seven days after calving, and milk from badly fed or overworked animals is also unfit for human use. The sale of the milk of cows which have not been thoroughly milked is considered fraudulent, as also entirely or partly skimmed milk (20 gm. of fat to 1 litre) if not declared as such, milk stated to be pasteurised which has not been freed from all pathogenetic microbes by a process approved by the Superior Council of Public Hygiene of France, and milk which is declared to be sterilised while containing living germs. It is considered to be adulteration to mix milk with water or any other substance, with the exception of such substances as are authorised for the preservation of milk by an order issued with the consent of the ministries of hygiene and agriculture, on the advice of the Superior Council of Public Hygiene of France. For cleaning and disinfecting the utensils used for manipulating, transporting and the retail sale of milk, the use of alcaline carbonates, hypochlorites, formaldehyde and oxygenated water is allowed, on condition that the passage of these substances into the milk is obviated by thorough cleansings.

In the manufacture of *condensed milk* only milk fit for the use of man can be used. It is obligatory to declare the date of manufacture aud the degree

of condensation. Only four denominations are allowed: condensed milk, condensed and sugared milk (which can only be manufactured with unskimmed milk), condensed skimmed milk, condensed skimmed and sugared milk. If the sugar is different from cane-sugar, even if only in part different, the fact must be stated.

The same rules are applied to *milk powder*.

The denomination of *casein* is reserved for the albuminoid substance of skimmed milk obtained from draining and drying the curds of completely skimmed milk. The use of bicarbonate of soda and phosphate of soda is allowed, provided it does not exceed 8 per cent. of the weight of the dried casein. The casein for human use must be odourless and not unpleasant in taste.

Cream must contain 30 per cent. of fats; diluted cream (with skimmed milk) at least 15 per cent.

Any addition of substances to cream is considered fraudulent unless for purposes of preservation, and all that is said above about milk is applicable to cream

Butter must not contain more than 18 per cent. of non-fatty substances containing not more than 16 per cent. of water. Butter may be coloured by vegetable substances; salting is allowed, if not over 10 per cent. of commercially pure salt is used (the declaration of this fact is obligatory), and the addition of small quantities of saltpetre and sugar is permitted; the remaking of butter is also allowed if done by working it over in milk or water with a small addition of bicarbonate of soda, the butter being expressly labelled as remade. The water used in the making of butter must be good drinking water. All that has been said above about milk applies to butter, as far as concerns the preservation of ingredients and the cleansing of utensils.

Cheese containing less than 15 per cent. of fat must be sold under the title of "skimmed milk cheese," excepting cheeses that are customarily made of skimmed milk. Any cheese made of milk other than cows' milk must be so declared unless of an obviously different type. The "double cream cheese" must contain at least 60 per cent. of dry fats, the whole milk cheese at least 40 per cent.

Salt, herbs, spice, ferments and colouring moulds are allowed to be used in the mixing of the cheese paste; bicarbonate of soda may be used for salting the cheese externally and paraffin may be used; incorporation of fats other than butter is allowed, as long as the kind of fat used is declared.

The title of *rennet* is reserved for the liquid or thick extract derived from the maceration of the stomach membrane of an unweaned calf. Commercially pure salt, boracic acid, and salicylic acid may be added when used for preservation purposes, provided that the strictly necessary proportions are observed.—(*Decree of the Agricultural Information Office, Ministry of Agriculture*, No. 13, 1924.)

The International Regularisation of the Cheese Trade.—The following recommendations were formulated and presented by a commission appointed by the Italian Section of the International Dairy Federation at the World Dairy Congress held at Washington (October 1923).

This Congress, recognising the advantage of placing the cheese industry under definite international control, recommends that in every country or state (1) there be established a minimum of fat in the percentage of dry material of the cheeses made with unskimmed milk generally exported; (2) that cheeses made from partially skimmed milk be marked to show the proportion of milk that has been skimmed (the cheeses being indicated as made from half, three-parts or four-parts skimmed milk, etc.); (3) that studies should be encouraged to ascertain the quantity of water present in the different types of cheese and at their different stages of ripeness, for the benefit of the cheese trade. The Congress also decided (4) that the origin of the cheese should be clearly indicated, the indications to include the name of the type of cheese and of the country in which it is manufactured.—(*Records of the Experimental Cheese Factory at Lodi, vol. ii., No.* 5-6, *pp.* 153-157, *Lodi,* 1924.)

The Function of Grit in the Gizzard of the Fowl. *Kaupp, B. F., Journal of Agricultural Research, Vol. XXVII., No.* 6. *Washington, D.C.*, 1924.—The first

points to be considered in the study of nutrition in poultry are the part played by grit in the gizzards of the birds and the length of time it is kept in the gizzard, as by this means it can be determined how often the fowl should renew its supply of grit, whether it habitually uses an amount in excess of its requirements and whether, in this event, the surplus is retained in the gizzard. The author's experiments were conducted on Barred Plymouth Rocks, two or three years of age ; the birds were kept in pens provided with a false bottom of wire-netting, which allowed of the excrement being at once removed, so that the fowls could not take up any of the gravel that had been evacuated. The fowls were killed at different intervals and the grit-content of the gizzard was determined each time. The experiment lasted 365 days ; the food was analysed daily, and the birds were weighed every day in order to find out whether the supply of grit they had taken up was enough to allow it to insure normal physiological functioning of the gizzard. The author gives a table showing the results of his experiment. From this data it can be seen that a bird can be given no grit for 365 days and yet have sufficient left in the gizzard to crush its food. At the end of this period, one fowl had still 5·89 gm. grit in its gizzard, viz., as much as was present in a bird killed on the 36th day of the experiment. Further, the grit is as angular at the end of the time as at the beginning. According to the author, the digestive process seems to be as follows :—The foods ingested are absorbed by the crop more or less thoroughly according to the time they remain in this organ and then pass into the proventriculus, where they are subjected to the action of the secreted acid juices, and finally enter the gizzard. The walls of the gizzard contract and by means of a rotary movement crush up the food with the action of a mill. The particles of grit swallowed with the food aid in the process. It has been found that the health of the birds is not affected whether the grit is angular or rounded.

Fowls have a tendency to take up more grit than they require ; the excess is evacuated with the excrements The amount retained in the gizzard varies according to the individual. One fowl that died on the 156th day had 14·03 gm. in its gizzard, which is far more than was found in the gizzards of birds killed on the 14th and 21st day respectively.

Effect of Age on the Hatching Quality of Eggs. *Lenoncio, M. O., The Philippine Agriculturist, Vol. XII, No. 8. Los Baños, Laguna,* 1924.—The author, basing his work on the results of the experiments carried out in the United States by Lamson and Kirkpatrick, Waite and Dryden, made a study under the conditions obtaining in the Philippines of the following. (1) the maximum period during which eggs for hatching can be kept ; (2) the best age for setting eggs in order to obtain most chicks at least cost ; (3) the best time of year for hatching. The experiments conducted at the Agricultural College of the University of the Philippines at Los Baños were begun in December 1921, and concluded in August 1922. The eggs came from Barred Plymouth Rocks and Canton fowls, and were hatched under hens. As soon as it was certain that a hen wished to sit, she was given a dozen eggs all alike in size, shape and shell structure These eggs had been kept in a dry, well-ventilated case ; the date of laying was written in red ink on each egg. Under each sitting hen were placed 3 recently laid eggs, 3 five days old, 3 ten days old and 3 a fortnight old. The eggs were inspected on the seventh and the fourth day after they had been put under the hen. The sitting hens were given maize and whole rice and had free access to water and to a bath made of two parts dust and one part lime. At first the hens were lifted from their nests, morning and evening, at feeding time and put back on the nest after 20 minutes, but from the 19th day of incubation they were no longer allowed to leave their nests. The results were practically the same for both breeds. The percentage of infertility rises with the length of time the eggs are kept before incubation, independently of the season. The best results are obtained by setting newly-laid eggs.

The evaporation of the water in the eggs, which increases with the time they are kept, and the rise of the external temperature, has a very injurious effect upon the vitality of the germinal vesicle of the egg. During December, January and February, the maximum time eggs for hatching can be kept is two days : in the warm months, the eggs must be set when fresh. The small number of eggs that hatch out in warm weather is probably also to be attributed to the fact that the sitting hens often leave the nests for a time, so that the clutch gets chilled.

Natural Control of Insect Pests. *T. B. Chamberlin, U.S. Dept. Agr. Circ.* 301, *April* 1924.—In his account of the efforts made to combat the alfalfa weevil, the author indicates how efficient the exploitation of natural enemies may be. The alfalfa weevil, a native of the Old World, was introduced to the neighbourhood of Salt Lake City some time prior to 1907. Its spread and increase in destructiveness in the United States have been remarkable, and suggest that the weevil had escaped from the natural influences which had controlled its numbers in its native lands. Accordingly, skilled entomologists spent a part of 1911 to 1913 investigating the natural enemies of the alfalfa weevil in Italy, Sicily, Switzerland and Southern France. They brought 12 species of parasites from Europe to the United States, and 10 of these have been liberated in Utah Five of them showed some promise of good work, but one, *Bathyplectes curculionis*, has not only become firmly established, but has spread until it swarms in the infested fields in Utah. More than that, it is doing better for the American farmer than ever it has done for the European, for whereas in Europe the highest average of parasitism by all the species which attacked the larva was 12·6 per cent, in Utah this parasite alone destroys over 90 per cent. of the weevil larvæ in the older sections. Natural control by imported parasites promises to solve the alfalfa problem of the west.

Experimental Work on Insecticides.—On account of the danger to farm live stock which arises from the use of arsenical preparations as insecticides, and partly also on account of the possibility of a shortage of arsenic or a serious rise in price due to the rapid increase in the use of such poisons, various investigators have had in view in their experiments the possibility of substituting an effective and cheap insecticide, innocuous to birds and mammals. Two papers bearing on this question appear in a recent number of *The Bulletin of Entomological Research* (August 1924); both point to the possibility of using sodium fluoride. This substance, sold in the form of a fine white powder, is prepared from the mineral cryolite as a by-product, and as a consequence of the limited uses to which it has hitherto been put, its pre-war price was 4d. per lb. It is much less harmful to stock than the arsenical poisons. A 15 grain dose is reported to have killed a 20 lb. dog in 4 days, but ½ to 1 grain of arsenite of soda is a lethal dose. A healthy fowl was allowed to feed at will for 3 days upon locusts, which had died of sodium fluoride poisoning, without showing any signs of being affected. As to its efficacy, Dr. L. B. Ripley found that it was effective as a stomach poison for cutworms (larvæ of *Euxoa*) and the brown locust of South Africa; grass treated with 2 per cent. solution of sodium fluoride gave good results in the case of the latter, bait treated with 1 per cent. solution in that of the former. In neither case was the substance so toxic as arsenite of soda, notwithstanding the American experiments on earwigs, which indicate that with them it is at least as effective. Mr. Hargreave's experiments were made with many substances, used against caterpillars infesting cabbage and lupin. A few of the organic compounds, such as the dinitrocresylates and naphthalene derivatives, he found to have high toxicity, but his results also emphasised the value of barium and calcium fluorides, and the possibility of the use of fluor-spar as an insecticide.

Root Round-Worms. *H. H. Zimmerley and H. Spencer in Virginia Agric. Stn. Bull., Vol.* 43.—Experiments have been carried out by the authors over a period of 10 years to determine a method of destroying root round-worms (*Heterodera radicicola*) in greenhouses and cold frames. Ordinarily these attack the roots and lower stems of plants, and infection is carried with soil, in which the worms may be present in large numbers. A recognised method of ridding infected soil of the worms is by the application of steam, but the authors endeavoured to discover a remedy which could be applied where steam was not available. They found that in both greenhouses and cold frames the application during mid-summer, when the nematodes are most active, of boiling water at the rate of 5 gallons per cubic foot of soil was effective. Where hot water boilers of considerable capacity are available, the authors consider this method of soil sterilisation would be of practical commercial value. They found that the usual types of chemical used for insect destruction, even when used under favourable conditions and in large quantities, were ineffective against the round-worms; substances used included carbon disulphide, sodium cyanide, calcium cyanamide and formaldehyde.

Bees and their Care of the Young. *J. A. Nelson, A. P. Sturtevant and B. Lineburg in U.S. Dept. Agr, Dept. Bull. No.* 1222, 1924.—After the hatching of the egg of a queen bee in its cell, the larva becomes a source of constant care to the worker bees. The attention paid to early nurture is indicated by the observation that each larva is visited on an average 1300 times a day by nurse bees during the period between hatching and the capping of the cell when the larva has reached full development; so that during this period of 8 days each larva receives over 10,000 visits. These visits are arranged with some sort of relation to the food requirements of the young; it was noticed, for example, that if the number of visits fell short during one part of the time, the average was restored by extra visits during the succeeding period. Further, a reduction in the total number of visits resulted in a dwarfed pupa from which emerged a correspondingly dwarfed adult bee. The feeding is not a uniform process throughout larval life. During the first two days after hatching, food elaborated by the nurse bees is supplied to the larva, and this food is practically all placed in the cell soon after the egg has hatched. This mass feeding is replaced after the second day by a more individualistic type of feeding. The food now contains a considerable amount of undigested pollen, and is fed to the larva at approximately the same rate at which it is devoured. The authors suggest that with older larvæ there may be reciprocal feeding between nurse bees and larvæ, as has been observed amongst ants and wasps. At any rate a very considerable amount of time is actually passed by the nurse bee within the larval cell, as much as 4¾ hours during the last day before the cell is capped. The practical lesson taught by these observations is that care of brood must seriously hamper the gathering of honey, for which the agriculturist primarily keeps his bee stocks, and that consequently, if full advantage is to be taken of the summer honey flow, it is desirable to reduce at this period the amount of brood requiring attention. This has the double advantage of setting free more field workers for honey collection, and of saving honey which would be used for the feeding of brood which might fail to emerge in time to help with the gathering of the honey harvest.

Horse-flies and Agriculture in the Western States. *J. L. Webb and R. W. Wells in U.S. Dept. Agr., Dept. Bull* 1218, 1924.—Horse-flies, blood-sucking two-winged flies belonging to the family *Tabanidæ*, form a serious pest to horses, cattle and other domestic animals, and especially in certain of the cattle-growing areas in the Western United States where swampy areas exist they are pests of great economic importance. Their harmfulness is largely due to direct damage caused to stock through blood-sucking. This may seem a matter of little moment, but in reality it is of very practical importance. Eight "greenhead" flies (*Tabanus phænops*), in gorging themselves, have been estimated to take 1 cubic centimetre of blood; other larger flies take more. Now in a season when horse-flies are common as many as 33 to 40 may be seen feeding on one cow, each taking about 8 to 10 minutes to complete its meal, so that in the course of a day the loss of blood to an animal, caused by 25 to 30 flies feeding for six hours, may amount to 100 cubic centimetres. Apart from such direct damage there are several ways in which indirect loss arises from the presence of horse-flies. They cause loss of weight and retardation of fattening, since by causing horses and cattle to bunch for better protection they interrupt daytime feeding. They are the source of many cases of runaways, of broken harness, waggons and fences. They may transmit from one animal to another the organism of the disease surra; they have been convicted, experimentally, of transmitting anthrax, and the field evidence against them is strong; and "deer-fly disease" among human beings is due to one of them (*Chrysops discalis*). The pamphlet referred to above describes the life histories of the species involved and discusses natural enemies of tabanids and the possibility of transporting such parasites to heavily infested localities. The authors indicate that repellants applied to live stock are of little value, and that poisoning with baits is ineffective. Horses may be protected by a hood, protecting head and neck, and a body cover; but the ultimate control of the horse-fly pest appears to lie in the better drainage of wet and swampy places in which the larvæ live.

An Electrical Method for Reduction of Draught in Ploughing *Crowther, E. M., and Haines, W. B., Journal of Agricultural Science, Vol. XIV., Part 2.*

Cambridge, 1924.—A large fraction of the work done in ploughing arises from the friction between the mouldboard and the soil, the amount having been estimated at one third.

The authors propose a simple electrical method for the reduction of this friction, based upon the phenomenon of electroendosmose which is shown by moist soil. Soil colloids are negatively charged, and water will move through moist soil towards the negative electrode under the action of the electric current. It is suggested that, if a current be passed through the soil having the mouldboard of a plough as negative electrode, then the film of water formed at the soil-metal surface should act as a lubricant and reduce ploughing draught.

Large reductions were obtained in laboratory tests with a metallic slider moving over moist soil.

Preliminary tests showed that the draught of a plough is reduced by applying a current between the coulter and the mouldboard. The amount of reduction in draught obtained in the field experiments was too small to have any practical significance, as the gain would be outweighed by the cost of generating the electricity, but the possibilities of the suggestion are under consideration.

Tar, Smoke, and Coal Gas as Factors Inimical to Vegetation. *Priestley, H. J., Science Progress, Vol. XVIII., No.* 72. *London*, 1924.—The author has studied the various problems grouped under the above title and considers that the subject may prove of practical interest to the horticulturist and the public authority who is trying to provide avenues of shade trees in populous thoroughfares.

The problems are discussed under the following headings :—Tar, illuminating gas, the toxic action of traces of illuminating gas, smoke, the reasons for the toxicity of unsaturated hydrocarbons, gas poisoning and horticultural practice.

Technical Methods adopted for the Development of Agriculture in Norway.—The amount of territory under cultivation in Norway is in round figures 735,000 hectares (exclusive of woods, arable land, etc). Most of the properties are small, since 99 per cent. are of less than 10 hectares, although each cultivated and meadow area will have a certain area of wood and pasture land in addition.

The employment in common of technical methods for the development of agriculture is in part carried out under the care of the State Agricultural Administration, and partly by professional agricultural bodies. The central administration is under the Ministry of Agriculture, whose Director issues regulations for the encouragement of agriculture and stock-breeding.

The funds to be devoted to this work amount to 14 million crowns (1 crown = 13½d. at par). The following are the chief items of expenditure : direct grants towards the cultivation of the land, 3 millions ; settlement (including "Ny Ford") 1 million ; funds for the cultivation of uncultivated areas, 1 million ; farm schools for peasants and training schools for country women, 2,165,000, the different districts contributing one quarter of the maintenance cost of these schools ; staff salaries and travelling expenses, 1 million ; centres for field experiments, 487,000 ; depots for cereals and grinding-stones, 650,000 ; grants for the construction and maintenance of fertilizer factories, 300,000 ; grants to agricultural societies, 1,180,000 ; to stock-breeding associations, breeders of pedigree cows, etc., control of milk production and farm accountancy, 540,000 ; local agricultural offices, 200,000 The different districts also contribute to the last three items of expenditure.

The work of breaking up and colonising the land has, of late years, contributed very largely to the development of agriculture.

In 1917 a special department of the Ministry of Agriculture was opened to stimulate and encourage agricultural production. At the same time a great deal was done to break up the vast uncultivated areas which exist in Norway, and this is to-day the chief work of the department.

Between the years 1918-1923, 30,400 hectares of land have been broken up and brought under cultivation at a net cost of 106 million crowns, to which the State contributed 30·3 millions, besides furnishing loans to the amount of 30·3 million crowns. Of this total area, 19,650 hectares were broken up between the years 1919 and 1920.

The greater part of the grants made by the State for the colonisation of the interior are administered by the association "Ny Ford."

The professional agricultural corporations include a number of institutions and officials who are paid out of the State funds, or by contributions from the different districts, though some are paid entirely by the contributions of members.

(1) One of the oldest of these societies is the Royal Society for the prosperity of Norway ("Selskapet for Norges Vel"), founded in 1809. Beginning with a very wide field of activity, it gradually restricted its work and became what it is to-day, an essentially agricultural society. Various other societies ("land-lniksselskapene") became affiliated to it, but these are tending more and more to come into closer relations with the State, as the State subsidies increase. Up to the present the work of this society has consisted chiefly in the study of new questions and in the formation of new institutions, which, when fairly launched, come under the State. Recently the Society has undertaken more permanent work, such as scientific inquiry, and some propaganda work. It also holds conferences on agricultural questions of the day, and issues the monthly review *Tidskrift for det Norske Landbruk.* It is subsidised by the State to the extent of 190,000 crowns. The activities of the affiliated societies include all the principal branches of agriculture.

(2) The Agricultural Societies ("Landlikssselskapene").—The greater part of the grants made by the State towards the encouragement of agriculture have been for some time administered by the agricultural societies. There is one such society in each of the 18 "fylker" or provinces. They mostly date from the end of the 18th century to the beginning of the 19th. They take an active part in the breaking up of the land, and since the reform of 1919, may be considered as being local provincial branches of the Ministry of Agriculture. This close collaboration allows a large measure of decentralisation, which is a necessity owing to the peculiar conditions of the country.

(3) "Ny Ford."—This association was founded in 1907 by various agricultural societies as well as commercial and industrial organisations for the purpose of restricting emigration, and helping emigrants wishing to be repatriated. At present, however, it is chiefly concerned with internal land settlement. Various other associations of a local character also work for this end, all subsidised by the State Up to July 1st, 1922, the "Ny Ford" held 1635 hectares of land, of which it had distributed 1130.—(*N. Krosby, Nordiske Jordbruksforsking, Vol. I., suppl.* 3, 1923)

The Formation of "Standards" in the United States.—A recent circular issued by the Chamber of Commerce shows what has been done to simplify the manufacture of products. Following the Congress of March 1923, the manufacturers of milk bottles adopted a uniform size and model which will be presented for the approval of the producers. Another Congress held in March 1923 referred to the wide adoption of standard types for motor car accessories and portable parts. In July 1923 standard types were established for wire netting and steel fencing, and their adoption became compulsory on September 1st, 1923. A uniform type has been adopted for earthenware or terracotta goods, such as tiles, pipes, bricks, etc., and paint and varnish pots.—(*Communication by the Secretary of the International Chamber of Commerce. Bulletin économique de l'Indochine, Renseignements, Year* 28, *No.* 1, *Hanoi-Haiphong*, 1924.)

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in September, October and November 1924.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	SEPTEMBER.			OCTOBER.			NOVEMBER.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK :—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	70 10	63 10	47 7	70 5	62 10	45 10	72 2	64 5	45 7
Cross-bred (Shorthorn)	65 2	58 11	41 0	65 1	58 1	40 0	66 11	59 9	40 1
Galloway	61 5	55 9	...	59 10	54 0	..	61 11	56 6	.
Ayrshire	60 0	51 0	35 9	58 5	46 5	33 0	60 6	47 9	34 0
Blue Grey	.		.	. .			62 0	57 0	
Highland ..	61 7		...	63 9	59 0	. .	70 9	61 0	..
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES	12¾	6¼	5	16	7½	6	18	7½	6¼
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot ..	18¼	17½	13	17½	16¾	12¼	17¼	16¾	12¾
Half-bred .	17¾	17	11½	17¼	16½	11¼	17	16¼	11½
Blackface	18¼	17	12½	17¼	16	11¾	17	15¾	12
Greyface ...	18¼	17	9	17¾	16½	8¾	17½	16¼	8¾
Down Cross . .	17¾	16¾	..	17¼	16½	.	17¼	16½	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs . ..	11 6	9 10	...	11 8	10 2	...	11 11	10 6	.
Porkers	11 8	10 6	...	11 11	10 10	..	12 3	11 1	...

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	September. 1st.	September. 2nd.	September. 3rd.	October. 1st.	October. 2nd.	October. 3rd.	November. 1st.	November. 2nd.	November. 3rd.
STORE STOCK:—									
Store Cattle—	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head. £ s.	Per head £ s.	Per head £ s.	Per head £ s.
Aberdeen-Angus:									
Yearlings .. .	21 13	17 18	14 10	20 18	17 6	13 6	18 13	15 14	11 18
Two-year-olds ...	27 16	22 6	19 0	27 4	21 13	17 17	26 11	20 17	17 18
Cross-bred (Shorthorn):									
Yearlings	17 15	14 19	12 4	18 1	15 1	12 4	17 4	14 10	11 16
Two-year-olds ...	25 4	20 2	18 6	25 12	20 13	18 6	25 0	19 19	17 5
Galloway:									
Yearlings	18 13	.		18 10	14 0	..	17 10	.	
Two-year-olds	28 15	21 5		26 2	21 10	..	24 0	20 10	.
Ayrshire:									
Yearlings ..				13 2	9 17	..	12 0	9 10	6 5
Two-year-olds .		. .		16 15	14 0		..	...	.
Blue Grey:									
Yearlings .. .		.		16 10	...	..	16 10	14 0	
Two-year-olds .				26 10	.	.	23 18	19 0	...
Highland:									
Yearlings . ..	12 5	10 0	6 10	13 7	10 18	8 7	11 19	9 15	8 0
Two-year-olds ..	14 15	13 3	10 15	17 16	15 4	13 0	15 9	13 8	11 3
Three-year-olds ..	21 8		...	24 12	21 14	18 3	21 14	19 0	15 12
Dairy Cows—									
Ayrshire:									
In Milk .. .	36 14	28 10	16 5	37 10	27 7	16 0	34 9	26 11	15 8
Calvers	36 2	26 15	17 5	37 5	26 17	17 8	34 15	25 18	16 9
Shorthorn Crosses:									
In Milk	42 4	32 5	21 17	41 17	32 3	21 17	41 4	31 14	21 1
Calvers	40 16	30 19	21 11	41 8	31 7	21 18	41 2	30 10	20 12
Store Sheep—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	.	...	. .	56 8	53 11	35 5	..	56 5	..
Half-bred Hoggs ...	105 3	73 6		98 6	78 10	69 6	..	67 6	56 2
Blackface Hoggs ...	...	42 0	.	62 2	47 5	39 10	44 0	33 0	...
Greyface Hoggs ...	85 9	67 8	58 2	70 0	64 0	...	55 3	50 6	
Store Pigs—									
(6 to 10 weeks old)	29 2	17 11	...	26 9	17 6	...	26 4	16 11	..

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	Quality.	September.			October.			November.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
BEEF :—		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb d.	per lb. d.	per lb. d.	per lb. d.
Home-fed—										
Bullock or Heifer ..	1	9¾	10⅜	11⅝	9¾	9⅞	11⅝	10⅛	9⅞	12
	2	9½	8⅞	10⅞	9⅜	8¾	9⅞	9¾	8¾	10⅜
Bull . .	1	8½	8⅜	8⅝	8⅜	8¼	8¼	8⅝	8⅛	8½
	2	8	7¾	7	8	7⅜	7¼	8	7½	7½
Cow	1	6½	6¾	7⅜	6½	6½	7	7⅛	6⅝	7⅛
	2	6¼	6⅛	5	6	5⅞	5¾	6⅜	6	6
Irish—										
Bullock or Heifer ..	1	. .		10⅜	...	...	9¾	9¼	...	9⅜
	2	...	...	8	...	...	8⅛	9	.	7¾
Bull	1	..	...	7	.	...	7¼	..	...	7⅝
	2	...	..	6½	...	..	6½	...	.	6¾
United States & Canadian—										
Killed at Birkenhead	1	.	...	...	...	..	8½	...	..	8½
	2	...	...	...	..	.	..	.	...	...
,, Glasgow ...	1	...	...	10⅛	...	...	9⅝	...	..	.
	2	...	...	8⅝	...	...	8⅜	...	. .	..
Argentine Frozen—										
Hind Quarters .	1	..	6¼	...	...	5¾	..	...	6⅛	
	2	...	5⅝	...	..	. .	...	...	...	...
Fore ,, . . .	1	...	3⅞	...	...	4	...	...	5⅛	..
	2	...	3½	.	...	...	..		..	..
Argentine Chilled—										
Hind Quarters ...	1	...	7⅞	7½	...	7¼	7	...	7⅜	7¾
	2	...	7⅜	7⅛	. .	7	6½		...	7⅜
Fore ,, ...	1	...	4¼	4¼	...	4¼	4¼		5⅜	5⅜
	2	...	3¾	4	..	3¾	4	..	.	5
Australian Frozen—										
Hind Quarters ..	1	...	...	6⅝	...	.	6⅜	. .	...	6⅜
	2	...	...	6⅛	...	...	6	...	...	6⅛
Fore ,, .	1	...	..	3⅝	...	...	3½	...	...	...
	2	.	.	3½	...	. .	...	...	...	...
New Zealand Frozen—										
Hind Quarters .	1	...	...	6⅝	...	...	...	...	...	...
	2	...	...	6½	...	...	...	...	...	..
Fore ,, ...	1	...	...	3¾	...	. .	..	...	. .	.
	2	...	...	3½	...	...	...	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	17	15¼	16	17	14	15¾	16½	13½	15⅝
	60 lb. & over	...	14⅜	14½	...	13	14¼	15½	12⅜	14¼
,, Cross	under 60 lb.	17	15¾	16	17	14⅝	15¼	16½	14	14⅞
	60 lb. & over	...	14⅝	14	...	13½	13¾	15½	13	13⅞
Ewes, Cheviot	1	12	10¼	11¼	11½	9⅛	10¼	10¾	9½	10¼
	2	...	...	10	10¾	...	8½	10	...	8⅝
,, Blackface ...	1	12	...	10¾	11½	8	10⅛	10¾	7¾	9¾
	2	...	...	9	10¾	...	8	10	...	7¾
,, Cross	1	9	9⅝	9⅛	8⅜	8⅜	8½	8½	8½	8¼
	2	8	...	7	7⅜	. .	7¼	8	...	7⅝
Argentine Frozen ...	1	...	7¾	7⅝	...	7⅝	7⅝	...	8⅛	7¾
	2	...	7⅜	...	...	...	...	...	...	...
Australian ,, ...	1	...	...	7	...	...	...	...	...	...
	2	...	...	...	...	...	...	...	...	...
LAMB :—										
Home-fed	1	17	16	16	17	15¼	15½	...	13⅞	15⅛
	2	...	14½	11¼	...	13⅛	11⅝	...	...	12
New Zealand Frozen ...	1	...	12⅞	12⅛	...	12⅞	12½	...	13	...
Argentine ,, ...	1	...	10⅜	9⅞	...	...	10¼	...	...	...

Average Prices of Provisions at Glasgow.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	September. s. d.	October. s. d.	November. s. d.
Butter:				
Irish Creamery ... per cwt.	1	208 0	222 5	220 8
„ „ (Unsalted) „	1	215 3	232 0	231 0
Danish ... ... „	1	222 9	248 7	231 6
„ (Unsalted) „	1	232 9	258 7	241 6
New Zealand ... ... „	1	217 6	231 7	226 0
Cheese:				
Cheddar ... ... „	1	112 0	112 0	112 0
	2	103 0	107 2	109 0
Dunlop ... ... „	1	94 0	102 0	105 6
	2	90 0	96 10	99 6
Canadian ... ... „	1	95 3	99 7	100 6
New Zealand (Coloured) „	1	100 3	102 5	103 0
„ (White) „	1	104 0	104 0	103 0
Bacon:				
Ayrshire (Rolled) ... „	1	155 0	153 2	148 6
Irish (Green) ... ... „	1	...	...	137 0
„ (Dried or Smoked) „	1	142 0	142 10	141 3
„ (Long Clear) ... „	1	143 3	134 5	127 0
Wiltshire (Green) ... „	1	...	...	...
„ (Dried or Smoked) „	1	...	...	...
American, Long Clear Middles (Green) „	1	103 3	108 2	109 3
American, Short Clear Backs ... „	1	105 0	112 10	116 0
American, Bellies ... „	1	96 0	105 2	112 0
„ Sides ... „	1	...	...	101 0
„ Cumberland Cut „	1	98 6	107 10	108 6
Canadian, Sides ... „	1	103 0	108 0	106 6
Danish, Sides ... ... „	1	112 6	117 2	119 6

Description.	Quality.	September. s. d.	October. s. d.	November. s. d.
Hams:				
Irish (Smoked) per cwt.	1	194 0	190 5	180 0
American, Long Cut (Green) ... ... „	1	102 6	112 7	122 0
	2	98 6	107 2	117 0
American, Short Cut „	1	88 9	104 5	107 0
	2	86 9	101 2	102 0
Canadian, Long Cut „	1	...	...	118 0
Eggs:				
Country ... per doz.	1	2 5	3 1	3 6
	2	2 3	2 10	3 4
Irish ... ... per 120	1	19 9	24 4	28 0
	2	18 5	23 4	26 6
„ (Stored) .. „	1	18 3	19 6	21 0
	2	17 3	18 11	20 0
„ (Duck) ... „	1	17 2	20 0	25 0
Argentine ... „	1	...	19 6	19 9
	2	...	17 0	18 11
Canadian (Fresh) „	1	...	21 9	24 0
	2	...	...	23 0
„ (Stored) „	1	...	19 11	21 3
	2	...	19 4	20 3
Chinese ... ... „	1	14 2	14 2	15 2
	2	13 2	14 0	14 6
Danish ... ... „	1	20 5	24 0	30 6
	2	18 10	22 8	28 6
Dutch ... ... „	1	18 2	23 3	26 0
„ (Duck) ... „	1	15 1	...	19 2
	2	12 0	...	...
Egyptian ... „	1	...	...	13 6
Polish ... ... „	1	14 0	16 2	...
	2	13 0	...	...
Russian ... „	1	12 9	16 7	18 1
	2	11 9	15 5	17 5

Average Prices of Potatoes at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Market.	Quality.	First Earlies.	Second Earlies.	Late Varieties.			
				Red Soils.		Other Soils.	
				Langworthy and Golden Wonder.	Other.	Langworthy and Golden Wonder.	Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
		SEPTEMBER.					
Dundee ...	1	5 0 0	6 0 0	...	...	...	...
	2	...	...	...	...	...	...
Edinburgh ...	1	...	5 18 0	...	...	...	...
	2	...	...	...	...	...	...
Glasgow ...	1	5 7 0	5 14 0	...	...	...	...
	2	...	...	...	...	...	...
		OCTOBER.					
Dundee ...	1	...	8 10 0	...	...	...	10 0 0
	2	...	...	...	...	...	...
Edinburgh ...	1	...	8 12 0	...	...	...	9 10 0
	2	...	...	...	...	...	...
Glasgow ...	1	...	9 1 0	...	...	13 14 0	10 0 0
	2	...	...	...	...	...	...
		NOVEMBER.					
Dundee ...	1	...	...	...	...	...	9 5 0
	2	...	...	...	...	...	...
Edinburgh ...	1	...	...	...	...	...	9 4 0
	2	...	...	...	...	...	...
Glasgow ...	1	...	9 4 0	14 13 0	12 0 0	13 7 0	9 17 0(a)
	2	...	...	...	...	...	9 4 0(b)

(a) Kerr's Pink. (b) Arran Chief.

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Market.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.
SEPTEMBER.										
† Dundee ...	1	...	21 3	...	91 3	...	95 0	91 3	92 6	46 0*
	2	...	...	...	...	...	...	...	...	...
‡ Edinburgh	1	...	...	...	74 5	...	71 3	70 0	70 10	45 0§
	2	...	...	...	70 0	...	...	...	...	40 0**
‖ Glasgow ...	1	...	...	...	82 6	82 6	75 0	70 0	80 0	37 6
	2	...	...	...	...	...	...	...	...	...
OCTOBER.										
† Dundee ...	1	...	21 6	42 6	98 0	...	97 0	91 3	92 6	46 0*
	2	...	...	...	...	...	...	...	...	...
‡ Edinburgh	1	...	...	...	89 0	...	70 6	56 3	65 6	45 0§
	2	...	...	...	85 0	...	...	...	...	40 0**
‖ Glasgow ...	1	...	...	...	85 0	90 0	58 0	...	60 0	37 6
	2	...	...	...	...	...	...	...	...	...
NOVEMBER.										
† Dundee ...	1	40 0	22 6	38 4	103 9	...	90 0	90 0	90 8	46 0*
	2	...	20 0	...	...	...	...	...	...	...
‡ Edinburgh	1	...	...	...	100 8	...	68 9	55 0	63 2	45 0§
	2	...	...	...	88 4	...	...	...	...	40 0**
‖ Glasgow ...	1	...	...	...	86 3	92 6	55 0	...	60 0	37 6
	2	...	...	...	...	...	...	...	...	...

† Quotations for Hay and Straw, baled and delivered.
‡ " " " delivered loose in town.
‖ " baled Hay and Straw, f.o.r.

* At Quay.
§ Dutch.
** Home.

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	September.		October.		November.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake— Home	13 13 9	13 2 6	14 3 0	13 11 0	14 5 0	13 15 0
Foreign . . .	13 4 5	.	13 12 0	...	13 13 9	
Decorticated Cotton Cake .	.	..	14 0 0	...	13 17 6	.
Undecorticated Cotton Cake— Bombay (Home-manufactured) ..	8 8 9	8 2 6	8 14 6	8 12 6	9 0 0	8 11 3
Egyptian (Home-manufactured) .	9 5 0	.	9 10 0	..	9 15 0	
Groundnut Cake— Undecorticated	*10 10 0		..	†10 15 0	*10 18 4	†10 15 0
	**11 0 0	.	.	.	**11 5 0	
Maize Germ Cake— Home ..	12 10 0		13 9 6		13 6 3	
Foreign	12 0 0	.	12 15 0	.	12 5 0	..
Maize Germ Cake Meal	12 3 9	.	13 10 0	. .	13 10 0	
Bean Meal . .	‡13 3 9	11 10 0	‡13 5 0	‡12 15 0	‡13 1 3	‡12 15 0
Maize Meal	11 5 0	11 2 6	12 7 6	12 1 0	12 5 0	12 10 0
Locust Bean Meal ...	..	8 5 0	. .	8 5 0	.	8 5 0
Locust Beans (Kibbled and Stoned)	..	7 10 0	...	7 10 0	..	7 10 0
Maize Gluten Feed (Paisley) ...	10 10 0		11 6 0	.	11 8 9	
Maize ...	§10 7 6	10 2 6	§11 8 9	11 1 0	§11 5 0	11 10 0
	‖11 10 0		‖12 1 3	. .	‖11 7 6	
Oats, Canadian (No 2 Western)	11 13 2		12 12 0		12 15 0	
,, Plate . ..	9 15 9		11 1 6		11 3 9	
,, Home (New)	11 10 0	10 10 0	11 0 0	10 14 0	10 13 9	11 0 0
,, ,, (Old)	12 2 6	..	12 18 0	. .	12 11 3	
Barley (Feeding) ...	. .	..	11 10 0	12 10 0	12 15 0	12 10 0
Barley Bran ..	11 16 3	.	12 5 0		12 0 0	
Malt Culms. ...	7 10 0	5 10 0	8 0 0	...	9 0 0	.
Distillery Mixed Grains—Dried	9 0 0	9 0 0	9 18 0	9 14 0	10 1 3	10 0 0
Distillery Malt Grains—Dried ..	9 3 9	...	9 18 0	...	10 5 0	.
Brewers' Grains— Dried	8 18 9	7 10 0	9 10 0	9 0 0	. .	9 0 0
Wet ...		1 12 6	.	1 12 6		
Wheat— Middlings (Fine Thirds or Parings)	11 5 0	10 15 0	11 11 0	11 4 0	11 13 9	11 10 0
Sharps (Common Thirds) .	9 5 0	9 5 0	9 10 0	9 9 0	9 4 4	9 15 0
Bran (Medium) ...	8 15 0	8 7 6	9 3 0	9 0 0	8 16 3	9 0 0
,, (Broad) ...	9 0 0	9 2 6	9 8 0	9 10 0	9 1 11	9 10 0
Feeding Treacle .	8 16 11	8 15 0	8 19 6	9 2 0	8 18 2	9 5 0
Fish Meal	19 1 3	17 15 0	19 5 0	19 0 0	20 1 11	19 0 0
Beans—English ...	.	...	13 10 0	...	14 0 0	. .
China ...	11 10 0	...	11 12 6	...	11 8 9	...
Morocco ...	12 0 0	...	12 0 8	...	12 0 0	. .
Pease— Calcutta White ...	11 11 8	...	11 15 0	...	12 10 0	.

* 37 per cent. Oil and Albuminoids.
** 40 per cent Oil and Albuminoids.
† 8 per cent. Oil and 31 per cent. Albuminoids.
‡ Pure China Beans.
§ Plate.
‖ South African (Yellow).

STATEMENT SHOWING THE ACREAGE UNDER EACH VARIETY OF POTATOES IN SCOTLAND IN 1924.

VARIETY.	Acres.
A. FIRST EARLIES	
1. America*	40
2. Arran Rose*	65
3. Dargill Early*	160
4. Di Vernon*	38
5. Immune Ashleaf* ...	135
6. Snowdrop (including Witch Hill)* ...	146
7. Beauty of Hebron (including Puritan) .	120
8. Duke of York (including Midlothian Early and Victory)	1,728
9. Eclipse (including Sir John Llewelyn) ...	1,759
10. Epicure	8,883
11. May Queen	257
12. Myatt's Ashleaf Kidney	34
13. Ninetyfold ..	154
14. Sharpe's Express .	2,034
15. Sharpe's Victor ..	82
16. Other First Earlies not specified above ...	104
Total First Earlies ...	15,739
B. SECOND EARLIES.	
17. Ally*	585
18. Arran Comrade* ...	914
19. Catriona* .	31
20. Edzell Blue*	410
21. Great Scot* . ..	9,128
22. Katie Glover*	190
23. King George V* ..	347
24. K. of K.*	58
25. British Queen (including Pioneer, Macpherson, Maid of Auchterarder, Scottish Standard, English Beauty, etc.)	5,568
26. Royal Kidney (including Queen Mary)	170
27. Other Second Earlies not specified above ...	183
Total Second Earlies	17,584

VARIETY.	Acres.
C. MAINCROPS.	
28. Sutton's Abundance (including Admiral, Balmuir, Bloomfield, Culdees Castle, Kerr's New White, Laing's Prolific, Lomond, Twentieth Century, Osborne Seedling, Just in Time, etc.)*	1,854
29. Arran Victory* ...	570
30. Bishop*	89
31. Champion*	1,679
32. Crusader*	955
33. Early Market* ..	126
34. Golden Wonder (including Peacemaker)*	13,220
35. Irish Queen*	197
36. Kerr's Pink*	17,574
37. Langworthy (including Maincrop and What's Wanted)*	1,451
38. Lochar*	220
39. Majestic*	2,162
40. Rhoderick Dhu* ...	856
41. Templar*	71
42. Tinwald Perfection* ...	1,785
43. White City (including Carnegie)*	47
44. Arran Chief	18,938
45. Evergood	220
46. Field-Marshal	2,034
47. General	57
48. King Edward VII (including Red King) .	18,704
49. Northern Star (including Ajax, Allies and Aeroplanes)	151
50. President (including Iron Duke and Scottish Farmer)	346
51. Up to Date (including Dalhousie, Factor, Glamis Beauty, Scottish Triumph, Stephen, Table Talk, Laing's Imperial, etc.	2,846
52. Other Maincrops not specified above ...	669
Total Maincrops ...	86,821

TOTAL AREA RETURNED ... 120,144 ACRES.

NOTES.—(1) The variety "Nithsdale" (Second Early) was returned separately in 1923, but is this year included as "not specified."
(2) In the county of Inverness the districts of Skye, Harris, North and South Uist were excluded. In the county of Ross the Western and South-Western districts and the district of Lewis were excluded.
(3) Varieties marked thus * are immune from Wart Disease.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1924.

Collected 4th June 1924 (and comparison with 1923).

CROPS.

Distribution	1924	1923	Increase		Decrease	
	Acres	Acres	Acres	Per Cent	Acres	Per Cent
Total Area (excluding Water)	19,069,683	19 069 683				
Total Acreage under all Crops and Grass (a)	4,715,290	4 724 438			9,148	0 19
Arable Land	3,273 116	3 298,142			25 026	0 76
Permanent Grass (a) — For Hay	154 765	[illegible]	1 908	1 2		
Permanent Grass (a) — Not for Hay	1,287 409	1 273 439	13,970	1 10		
Permanent Grass (a) — Total	1,442,174	[illegible]	1[illegible] 878	1 11		
Wheat	49,449	[illegible]			9 340	15 89
Barley (including bere)	151,588	[illegible]			7,069	4 46
Oats	955,535	968 211			12,676	1 31
Mixed Grain	1,333	1 237	96	7 76		
Rye	6,635	6,406	229	3 57		
Beans (to be harvested as Corn)	3 732	3 803			1	1 87
Peas	499	469	30	6 40		
Potatoes	138,281	136 976	1 305	0 95		
Turnips and Swedes	405,693	409,642			3,949	0 96
Mangolds	1,316	1 631			315	19 31
Cabbage	4,139	4 278			139	3 25
Rape	11 843	14,342			2,499	17 4[illegible]
Vetches or Tares for Seed	269	336			67	19 94
Vetches Tares, Beans, Peas Mashlum etc, for Fodder	10,650	10 230	420	4 11		
Carrots	391	389	2	0 51		
Onions	161	17			12	6 94
Flax	126	607			481	79 24
Small Fruit	6,969	6 937	32	0 46		
Rye Grass and other Rotation Grasses and Clover — For Hay	415 322	414 527	795	0 19		
Rye Grass and other Rotation Grasses and Clover — Not for Hay	1 099,753	[illegible]	8,699	0 80		
Rye Grass and other Rotation Grasses and Clover — Total	1,515,075	[illegible]	9 494	0 63		
Other Crops	2,440	2 093	347	16 58		
Bare Fallow	6 992	[illegible]			363	4 94
Orchards (b)	1,344	1 41			71	5 02

LIVE STOCK.

Distribution	1924	1923	Increase		Decrease	
	No.	No.	No.	Per Cent	No.	Per Cent
Horses used for Agricultural purposes (including Mares for Breeding)	137,260	138 803			1,543	1 11
Unbroken Horses (including Stallions) — One year and above	27,515	34,336			6,821	19 87
Unbroken Horses (including Stallions) — Under one year	6,392	8,281			1,889	22 81
Total	171,167	181 420			10,253	5 65
Other Horses	22,529	22,413	116	0 52		
Total of Horses	193,696	203,833			10,137	4 97
Cows in Milk	352,256	361,742			9,486	2 62
Cows in Calf, but not in Milk	46,489	42,182	4,307	10 22		
Heifers in Calf	49,698	51,489			1,790	3 49
Bulls being used for Service	17,579	17,530	49	0 28		
Other Cattle—Two Years and above	214,596	225,441			10,845	4 81
,, ,, One Year and under two	263,440	265 387			1,947	0 73
,, ,, Under one year	220,394	229,869			9,475	4 12
Total of Cattle	1,164,397	1,193,590			29,193	2 45
Ewes kept for Breeding	2,992,113	2,903 307	88 806	3 06		
Rams to be used for Service in 1924	83,876	79,770	4,106	5 15		
Other Sheep—One year and above	987 267	1,002,436			15,169	1 51
,, ,, Under one year	2,822,896	2,800,210	22,686	0 81		
Total of Sheep	6,886,152	6,785,723	100,429	1 48		
Sows kept for Breeding	24,014	24 485			471	1·92
Boars being used for Service	2,721	2,625	96	3 66		
Other Pigs	172,101	158,917	13,184	8·30		
Total of Pigs	198,836	186 027	12,809	6 89	..	..

(a) Excluding Mountain and Heath Land used for grazing (9,672,778 acres in 1924).
(b) Any Crop or Grass grown in Orchards is also returned under its proper heading

ACREAGE under WHEAT, BARLEY (including BERE), and OATS in each COUNTY on 4th June 1924, with COMPARISON for 1923.

COUNTIES.	Wheat.		Barley (including Bere).		Oats	
	1924.	1923	1924.	1923.	1924.	1923.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN .	50	31	18,901	21,521	188,328	187,509
ARGYLL	...	...	1,226	1,325	16,007	16,415
AYR	726	1,081	166	318	41,658	43,306
BANFF	...	6	7,271	7,848	48,067	47,933
BERWICK	1,285	1,550	15,680	16,013	28,758	29,837
BUTE	3	7	29	12	4,823	4,985
CAITHNESS ...	...	...	545	691	29,876	30,252
CLACKMANNAN ...	228	411	183	182	3,267	3,204
DUMBARTON ...	378	644	12	36	7,146	7,434
DUMFRIES .	37	79	307	392	38,692	39,600
EAST LOTHIAN ...	4,115	4,953	14,923	14,618	16,805	17,469
FIFE	11,812	12,821	11,101	14,070	43,452	44,177
FORFAR	9,985	11,000	17,850	18,284	55,696	56,304
INVERNESS ...	34	18	4,678	5,238	30,514	30,042
KINCARDINE ...	910	1,193	9,948	10,425	30,014	30,020
KINROSS	149	177	179	172	6,840	7,019
KIRKCUDBRIGHT...	8	10	31	61	22,982	24,070
LANARK	1,502	2,317	107	129	38,113	38,759
LINLITHGOW ..	2,036	2,580	1,820	2,035	11,192	11,189
MIDLOTHIAN ...	4,702	5,646	4,830	4,841	21,484	21,709
MORAY	381	535	9,349	9,730	24,721	24,419
NAIRN	...	...	2,293	2,301	6,214	6,134
ORKNEY	...	...	3,589	3,471	33,098	33,698
PEEBLES	...	...	93	152	6,063	6,493
PERTH	7,418	8,455	3,809	4,251	68,957	71,675
RENFREW ...	1,595	1,975	62	19	10,197	10,209
ROSS & CROMARTY	393	574	8,011	8,806	31,502	31,184
ROXBURGH ...	355	478	9,246	9,104	25,092	26,503
SELKIRK	8	8	238	255	3,977	3,956
SHETLAND ...	...	...	636	651	6,446	6,464
STIRLING	1,334	2,194	874	998	18,539	18,549
SUTHERLAND ...	...	...	399	445	7,695	7,824
WIGTOWN	5	46	202	263	29,320	29,870
TOTAL ...	49,449	58,789	151,588	158,657	955,535	968,211

ACREAGE under BEANS, POTATOES, and TURNIPS and SWEDES in each COUNTY on 4th June 1924, with COMPARISON for 1923.

COUNTIES	Beans.* 1924.	Beans.* 1923	Potatoes. 1924.	Potatoes. 1923.	Turnips and Swedes. 1924.	Turnips and Swedes. 1923.
	Acres	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ..	11	23	7,329	7,355	81,585	82,273
ARGYLL	15	27	3,015	3,123	5,146	5,261
AYR	223	290	7,860	8,465	7,624	7,674
BANFF	25	31	1,735	1,734	20,032	20,171
BERWICK	177	181	2,597	2,470	21,158	21,469
BUTE	15	19	1,018	1,075	1,340	1,370
CAITHNESS ...		..	1,238	1,323	11,329	11,619
CLACKMANNAN ...	229	270	410	381	812	797
DUMBARTON ...	11	13	2,198	2,282	1,458	1,486
DUMFRIES ...		1	3,199	3,534	15,507	15,651
EAST LOTHIAN ...	63	88	7,678	7,511	12,913	12,580
FIFE	353	334	16,643	15,901	21,786	21,719
FORFAR	21	52	17,608	16,610	30,584	31,109
INVERNESS ..		2	5,302	5,218	8,995	9,290
KINCARDINE ..	21	29	4,307	4,134	15,282	15,569
KINROSS	5	1	1,148	1,179	2,383	2,449
KIRKCUDBRIGHT	4	5	1,324	1,376	10,072	9,999
LANARK			4,878	5,279	9,611	9,808
LINLITHGOW ...	33	55	2,340	2,381	3,391	3,359
MIDLOTHIAN ...	2	.	6,225	6,333	9,747	9,727
MORAY	11	15	1,557	1,502	13,683	13,892
NAIRN	.	..	265	283	3,755	3,855
ORKNEY		..	2,210	2,271	13,616	13,692
PEEBLES	1	...	281	314	3,038	3,033
PERTH	793	769	17,047	16,071	24,747	25,376
RENFREW	66	65	2,803	2,928	2,083	2,125
ROSS & CROMARTY	..	5	7,149	6,889	13,993	14,197
ROXBURGH ...	58	93	1,158	1,112	17,482	17,438
SELKIRK	..	...	154	156	2,125	2,050
SHETLAND ...	..	..	2,064	2,167	1,014	993
STIRLING	1,470	1,381	2,957	2,865	3,911	3,919
SUTHERLAND ...	...	...	1,168	1,193	2,796	2,834
WIGTOWN	116	54	1,416	1,561	12,695	12,858
TOTAL	3,732	3,803	138,281	136,976	405,693	409,642

* To be harvested as corn.

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1924, with COMPARISON for 1923.

COUNTIES.	Rye-grass and other Rotation Grasses and Clover.				Permanent Grass.			
	For Hay.		Not for Hay.		For Hay.		Not for Hay.	
	1924.	1923.	1924.	1923.	1924.	1923.	1924.	1923.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN	52,939	51,840	237,290	235,380	834	693	35,483	36,740
ARGYLL	11,926	11,924	16,027	15,861	15,066	15,063	55,551	58,233
AYR . .	28,226	27,354	47,952	52,389	22,653	22,286	153,292	147,155
BANFF ..	10,218	10,067	58,877	58,832	308	361	10,456	10,037
BERWICK ...	11,399	11,721	49,709	48,422	1,445	2,130	55,435	53,504
BUTE	2,448	2,291	5,162	5,720	320	317	9,933	9,437
CAITHNESS	10,076	9,704	26,781	26,593	770	671	25,700	25,526
CLACKMANNAN	1,420	1,359	1,310	1,836	917	1,021	6,287	5,672
DUMBARTON	5,774	5,650	5,919	5,918	2,191	2,107	20,377	20,514
DUMFRIES ..	20,432	20,525	48,958	47,915	19,103	18,169	97,742	98,591
EAST LOTHIAN	9,169	9,828	16,909	16,634	1,127	765	22,558	22,008
FIFE	27,016	27,800	30,842	30,519	2,781	3,431	69,925	68,178
FORFAR	22,962	22,585	61,717	61,192	1,072	1,568	25,373	24,045
INVERNESS	11,530	11,191	21,728	21,975	8,439	8,239	56,699	56,136
KINCARDINE ..	13,499	13,751	35,305	33,587	113	172	8,166	8,831
KINROSS ..	3,197	3,186	8,103	7,541	607	969	10,709	10,468
KIRCUDBRIGHT	10,460	10,187	53,347	52,012	12,593	12,526	70,066	69,961
LANARK ..	32,298	33,110	37,495	36,994	13,339	12,226	103,122	103,046
LINLITHGOW ..	7,108	7,249	4,613	5,314	1,425	1,281	22,133	20,948
MIDLOTHIAN .	11,554	11,805	16,081	15,315	1,899	2,169	40,111	39,801
MORAY ...	6,099	6,086	33,969	34,367	286	173	7,104	6,742
NAIRN	1,710	1,644	9,142	9,555	48	62	1,784	1,730
ORKNEY ...	8,508	8,897	31,847	30,630	583	417	13,491	14,028
PEEBLES ..	2,552	2,620	10,608	11,631	1,238	1,282	26,153	24,288
PERTH	34,753	34,172	63,241	60,598	11,085	11,232	87,614	87,807
RENFREW ..	9,320	9,443	7,165	6,993	7,190	6,704	42,111	42,619
ROSS AND CROMARTY ...	13,054	13,300	35,022	33,599	2,779	2,477	24,583	24 968
ROXBURGH ...	9,375	10,113	47,841	46,363	6,775	6,707	59,227	57,616
SELKIRK ...	1,300	1,260	7,894	7,375	1,952	1.815	12,007	12,549
SHETLAND ...	1,366	1,312	677	705	1,727	1,759	10,682	10,466
STIRLING ...	11,528	11,614	10,642	9,757	7,074	7,087	51,979	52,314
SUTHERLAND ...	4,588	4,476	5,807	5,544	1,555	1,512	7,269	6,774
WIGTOWN ...	7,518	6,463	52,773	53,988	5,171	5,466	44,287	42,707
TOTAL ...	415,322	414,527	1,099,753	1,091,054	154,765	152,857	1,287,409	1,273,439

NUMBER of HORSES, CATTLE, SHEEP and PIGS in each COUNTY on 4th June 1924, with COMPARISON for 1923.

COUNTIES.	Horses.*		Cattle.		Sheep.		Pigs.	
	1924.	1923.	1924.	1923.	1924.	1923.	1924.	1923.
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
ABERDEEN ...	26,028	27,669	164,594	173,105	222,624	204,126	22,276	21,030
ARGYLL ..	5,375	5,897	53,816	55,325	743,993	768,492	5,986	5,046
AYR . ..	8,835	9,559	109,973	109,414	363,449	350,105	17,506	15,651
BANFF ...	7,740	8,269	41,584	44.176	64.482	61,791	4,709	4,751
BERWICK ...	4,415	4,539	20,680	21,184	346,664	325,698	5,611	4,956
BUTE . ..	1,180	1,289	9,189	9,311	40,472	39,238	653	922
CAITHNESS ...	5,056	5,389	20,001	21,595	149,226	148,733	2,177	2,515
CLACKMANNAN	678	761	3,636	3,439	12,728	13,424	1,131	610
DUMBARTON ...	1,690	1,765	12,711	13,541	66,620	66,836	1,537	1,442
DUMFRIES ..	6,875	7,322	66,314	68,793	548,690	547,770	11,803	12,045
EAST LOTHIAN	3,270	3,331	12,247	13,320	134,706	130,362	4,830	3,567
FIFE	8,841	9,458	42,321	42,495	109,875	96,773	10,240	9,803
FORFAR.. ...	8,583	8,793	45,843	46,692	176,723	168,672	8,857	9,131
INVERNESS ...	7,789	8,066	45,290	46,943	506,541	501,675	2,099	2,267
KINCARDINE ...	4,352	4,557	25,638	24,817	54,434	44,913	4,122	3,802
KINROSS ..	1,100	1,175	6,161	6,107	30,728	32,188	848	933
KIRKCUDBRIGHT	4,831	5,260	56,033	56,839	367,078	363,550	15,594	13,465
LANARK ...	7,576	7,992	71,602	72,256	233,549	222,514	9,357	9,134
LINLITHGOW	2,091	2,206	11,377	11,851	18,875	15,694	2,331	1,865
MIDLOTHIAN ..	3,540	3,657	17,324	16,972	169,801	170,234	14,983	12,637
MORAY	4,347	4,666	21,846	22,831	48,611	46,068	3,902	3,235
NAIRN	1,241	1,301	6,367	6,419	13,950	13,960	812	786
ORKNEY .	5,863	6,399	30,557	32,285	33,026	34,459	1.739	2,043
PEEBLES ...	967	1,018	6,769	6,703	201,129	200,945	624	622
PERTH	11.323	12,014	63,677	66,112	594,113	592,700	11,815	11,326
RENFREW ..	2,596	2,774	25,508	25,506	40,103	38,038	3,623	3,723
ROSS AND CROMARTY ..	6,370	6,465	38,725	40,134	279,026	277,841	4,253	4,312
ROXBURGH ...	3,699	3,787	22,180	21,608	549,219	533,619	4,095	3,510
SELKIRK ...	579	560	3,659	3,395	186,386	183,497	823	771
SHETLAND ...	2,454	2,760	11,665	12,788	140,763	149,529	174	402
STIRLING ...	4,305	4,571	31,570	31,619	116,173	117,094	2,932	3,005
SUTHERLAND ...	2,114	2,197	9,684	10,527	203,166	207,146	743	843
WIGTOWN ...	5,464	5,954	55,856	55,488	119,229	118,039	16,651	15,877
TOTAL ...	171,167	181,420	1,164,397	1,193,590	6,886,152	6,785,723	198,836	186,027

* Horses used for agricultural purposes, mares for breeding, and unbroken horses (including Stallions). "Other Horses" on agricultural holdings are not included; the total of these for Scotland is given in the summary table on p. 114.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1924.

County and District of County.		Wheat.	Barley (including Bere).	Oats.	Beans.*	Potatoes.	Turnips and Swedes.	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	Horses.†	Cattle.	Sheep.	Pigs.
		Acres.	Acres.	Acres.	Acres	Acres.	Acres.	Acres	Acres.	Acres.	Acres.	No.	No.	No.	No.
ABERDEEN	Aberdeen	2	5,547	17,428	.	1,715	9,472	7,727	26,245	5	2,645	3,044	19,350	10,944	4,37
	Alford	.	667	16,785		341	7,883	5,431	20 912	67	6,151	2,298	15,718	39,199	877
	Deer		1,961	43,109	8	1,949	16,553	11,931	47,854	215	8,643	5,736	36,568	33,627	4,648
	Deeside	..	1,896	14,856		496	7,093	6,116	18,365	53	5,004	2,284	14,365	46,669	1,508
	Ellon	48	2,728	27,885		960	12,320	7,903	36,222	130	3,288	3,348	23,803	29,245	2,908
	Garioch	..	3,120	23,613	..	710	10,739	5,975	31,843	82	3,304	3,450	21,430	14,459	3,164
	Huntly	..	745	15,935	2	361	6,411	2,779	22,208	44	4,667	2,222	11,847	33,793	1,469
	Turriff	..	2,237	28,717	1	797	11,114	5,077	33,611	238	1,781	3,046	21,513	14,688	3,331
ARGYLL	Ardnamurchan	..		432		244	38	624	200	1,184	1,747	164	2,764	61,282	83
	Cowal			1,291	.	242	438	1,051	724	1,778	6,265	366	3,981	133 036	196
	Islay	..	5	3,855		544	1,182	3,060	2,784	1 622	17,906	1 119	9,704	74,318	691
	Kintyre	..	614	4,576	15	409	2,170	1,499	9,635	1,365	11,288	1,408	14,194	125,832	3,482
	Lorn	.	6	2,155		618	601	2,486	969	4,191	5,520	781	8,574	171 769	715
	Mid-Argyll	.		1,480		352	450	1,619	1,124	2,616	8,292	782	6,827	105,542	470
	Mull	.	601	2,218		606	267	1,587	591	2,310	4,538	955	7,772	72,214	349
AYR	Ayr	121	7	10,952	89	1,558	1,891	7,784	14,729	6,861	39,475	2,129	29,194	104 871	5,220
	Carrick	34	114	9,763	108	3,341	2,964	5,395	11,976	4 220	35,198	2 219	22,496	184,760	4,034
	Kilmarnock	287	23	10,610	10	886	1,338	8,120	12,067	6,485	40,834	2,223	32,003	32,664	5,955
	Northern	284	17	10,333	16	2,075	1,431	6,927	9,180	5,087	37 785	2,264	26,290	41,154	2,297
BANFF	Banff	..	6,284	26,715	24	1,226	11,984	5,658	33,955	38	2,479	4,456	25 425	17,314	3 481
	Keith	..	987	21,352	1	509	8,048	4,560	24,922	270	7,977	3,282	16 159	47,168	1,228
BERWICK	East	506	5,980	8,886	110	1,326	6,898	3,647	14,978	262	16,354	1,461	6,418	39,357	2,583
	Middle	663	7,745	9,768	60	850	7,092	4,915	14,967	679	19,871	1,713	8,263	117,851	1,830
	West	116	1,955	10,104	7	421	6,268	2,837	19,764	504	19,210	1,241	5,999	139,456	1,198
BUTE	Arran	.	19	2,329	15	619	447	1,212	2,260	216	4,772	581	4,492	31,629	330
	Bute and Cumbrae	3	10	2,494		399	893	1,236	2,902	104	5,161	599	4,697	8,843	323
CAITHNESS (not divided)		..	545	29,876	..	1,238	11,329	10,076	26,781	770	25,700	5,056	20,001	149,226	2,177
CLACKMANNAN (not divided)		228	183	3,267	229	410	812	1,420	1,310	917	6,287	678	3,636	12,728	1,131
DUMBARTON	Eastern	308		3,841	4	1,075	669	3,268	2,712	1,168	8,792	890	5,545	10,213	987
	Western	70	12	3,305	10	1,123	789	2,566	3,207	1,323	11,585	800	7,166	56,407	550
DUMFRIES	Annan	5	220	12,611	..	1,005	4,892	6,131	13,791	2,776	15,729	2,064	14,945	45 620	3,061
	Dumfries	30	58	9,273	..	1,016	3,611	4,163	12,091	2,693	14,461	1,457	13,398	50,120	3,080
	Langholm	..	6	2,271	.	175	996	1,409	3,127	2,972	7,717	486	5,097	121,581	492
	Lockerbie	2	16	8,678	.	601	3,707	4,795	11,910	6,020	26,724	1,660	17,579	147,177	1,965
	Thornhill	..	7	5,859	..	402	2,301	3,934	8,039	4,642	33,111	1,208	15,295	184,192	3,205

* To be harvested as corn.

† See Note on p. 118.

... SCOTLAND on 4th June 1924.

County and District of County.		Wheat.	Barley (including Bere).	Oats.	Beans.	Potatoes.	Turnips and Swedes.	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	† Horses	Cattle.	Sheep.	Pigs.
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
East Lothian	Eastern	1,186	6,016	5,266	18	3,233	4,834	2,982	6,949	821	8,179	1,208	4,058	64,987	1,555
	Western	2,929	8,907	11,539	45	4,445	8,079	6,187	9,960	306	14,379	2,062	8,189	69,719	3,275
Fife	Cupar	3,926	4,571	14,200	35	5,957	7,668	7,553	14,129	451	14,617	2,581	11,235	42,787	2,873
	Dunfermline	990	810	7,660	117	1,679	2,711	4,653	3,636	1,096	21,732	1,511	9,150	23,659	2,209
	Kirkcaldy	2,482	2,537	9,663	8	3,576	4,312	6,631	5,615	717	15,038	2,120	10,440	18,931	2,577
	St. Andrews	4,464	6,183	11,929	193	5,431	7,095	8,179	7,462	517	18,538	2,629	11,496	24,498	2,581
Forfar	Arbroath	2,670	4,705	10,052		4,208	6,318	4,714	10,235	116	3,485	1,753	8,869	3,489	1,342
	Brechin	2,402	6,221	17,421	24	4,158	9,723	7,111	19,773	279	6,708	2,476	13,311	64 047	2,613
	Dundee	2,650	2,717	10,202	..	4,482	5,811	4,679	10,196	305	3,886	1,717	9,138	18,151	2,703
	Forfar	2,263	4,207	18,021	.	4,760	8,732	6,458	21,513	372	11,294	2,607	14,525	86,036	2,199
Inverness	Inverness		1,946	7,282	.	418	4,175	2,802	10 910	132	4,274	1,492	6,585	39,285	990
	Aird	84	191	5,800		519	2,595	3,034	5,659	441	4,486	1,100	5,824	48,059	748
	Badenoch	..	70	4,068		181	1,615	2,255	4,024	1,505	9,106	725	4,482	92,551	153
	Lochaber	.	1	1,136		460	225	1,474	410	2,061	2,918	308	4,699	149,395	181
	Skye		2	5,645	.	1,386	287	1,655	557	2,903	5,655	1,007	9,168	125,274	8
	Harris, N. & S. Uist	.	2,468	6,583	..	2,338	98	310	168	1,497	30,260	3,067	14,632	56,977	19
Kincardine	Laurencekirk	271	2,118	9,286	1	1,427	4,241	3,488	9,595	38	1,870	1,080	6,308	20,771	1,177
	Lower Deeside	.	1,245	3,367	1	753	1,714	2,126	3,699		381	563	3,211	1,028	625
	St. Cyrus	582	2,091	5,962	13	1,054	3,909	2,457	6,204	50	1,807	819	3,826	11,041	555
	Stonehaven	57	3,010	7,807	9	790	4,172	3,747	9,904	16	2,915	1,196	8,321	14,114	1,226
	Upper Deeside	..	1,484	3,592	.	283	2,147	1,681	5,903	9	1,193	694	3,972	7,480	539
Kinross (not divided)		149	179	6,840	5	1,148	2,383	3,197	8,103	607	10 709	1,100	6,161	30,728	848
Kirkcudbright	Eastern	1	11	9,796		859	4,045	4,402	16,907	3,665	28,457	1,810	19,321	65,073	4,777
	Northern		4	1,711		126	793	832	4,593	2,883	9,284	522	5,481	139,387	1,010
	Southern	7	15	9,527	4	264	4,381	4,103	28,751	4,491	26,930	2,074	25,895	80,604	9,141
	Western	..	1	1,948	..	75	853	1,123	3,096	1,554	10,395	425	5,336	82,014	666
Lanark	Lower Ward	665	13	4,080		1,299	598	3,271	2,183	2,499	6,070	818	4,708	1,439	2,903
	Middle Ward	827	77	17,064		1,933	3,216	17,176	12,979	6,391	51,478	3,699	36,599	30,382	4,247
	Upper Ward	10	17	16,969	..	1,646	5,797	11,851	22,333	4,449	45,574	3,059	30,295	201,728	2,207
Linlithgow	Bathgate	180	316	5,357		579	1,216	3,405	2,255	1,086	13,737	1,084	6,468	8,107	446
	Linlithgow	1,856	1,504	5,835	33	1,761	2,175	3,703	2,358	339	8,396	1,007	4,909	10,768	1,885
Mid-Lothian	Calder	1,433	666	6,017	..	1,755	1,863	3,717	1,919	735	13,432	1,042	5,615	35,586	2,625
	Gala-Water	177	1,321	5,793	.	345	3,612	1,522	10,401	272	14,419	722	3,506	91,241	601
	Lasswade	920	1,805	5,742	.	1,636	2,785	3,592	3,339	607	8,500	273	4,200	34,486	1,959
	Suburban	2,172	1,038	3,932	2	2,489	1,487	2,728	422	285	3,760	803	4,003	8 488	9,798
Moray (not divided)		381	9,349	24,721	11	1,567	13,683	6,099	33,969	296	7,104	4,347	21,846	48,611	3,902

* To be harvested as corn

† See Note on p 118.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1924.

County and District of County.		Wheat.	Barley (including Bere).	Oats.	* Beans.	Potatoes.	Turnips and Swedes.	Rye-grass and other Rotation Grasses & Clover. For Hay.	Rye-grass and other Rotation Grasses & Clover. Not for Hay.	Permanent Grass. For Hay.	Permanent Grass. Not for Hay.	† Horses.	Cattle.	Sheep.	Pigs.
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
NAIRN (not divided)		..	2,293	6,214		265	3,755	1,710	9,142	45	1.784	1.241	6,367	13,950	812
ORKNEY	Mainland	..	1,077	18,334		1,166	7,000	4,989	17,328	385	6,938	3 245	15 998	13,508	866
	North Isles	..	2,202	9 882	.	721	4,781	2,317	10,632	144	5,419	1,877	10,447	14,444	680
	S. Ronaldshay & Walls	..	310	4,882		323	1,845	1,202	3,887	54	1,134	741	4,112	5,074	193
PEEBLES (not divided)			93	6 063	1	281	3,038	2,552	10,608	1,238	26,153	967	6.769	201,129	624
PERTH	Blairgowrie	2,139	1,863	15,677		4,857	6,513	7,165	15,960	427	12,711	2,311	12,320	58,179	2,798
	Central	615	160	14,724		3,370	4 817	7,479	13,842	1,692	18,023	2,326	11,611	121.572	2,252
	Highland	10	50	6,566	.	811	2,564	4,650	6 780	2,404	14,210	1,316	8,642	188,284	1,188
	Perth	4,409	1,534	22,013	270	6,498	8 610	9,807	18,977	1 823	24,709	3,308	18,727	57,370	4,129
	Western	245	202	9,977	523	1,511	2,243	5 652	7,682	4,739	17 961	2,062	12,377	168,798	1 448
RENFREW	First or Upper	1,046	42	4,567	14	1,105	987	4,411	2,434	4 269	21,466	1,182	12,418	19,291	1,902
	Second or Lower	549	20	5,630	52	1,698	1,096	4,909	4,731	2 921	20,645	1,414	13,090	20,812	1,721
ROSS & CROMARTY	Black Isle	2	2,742	6,693		764	4,012	3,279	9,712	83	1,374	1,317	5,839	14 541	1,098
	Easter Ross	391	1,882	9,778	..	1,424	5,348	4,032	13 551	339	5,720	1,340	8 557	69 568	1,793
	Mid Ross	..	1,311	9,026	.	752	4,262	4,068	11,197	466	5 596	1,681	8,889	74,974	1,280
	S.-W. and Western	.	8	1,888		622	198	1 518	479	1,461	2,055	371	4,328	71,790	71
	Lewis		2,068	4,117	.	3,587	173	157	83	430	9,838	1,161	11,112	48,144	11
ROXBURGH	Hawick & Liddesdale	1	126	3,547	.	159	1,906	1 381	5,122	3,586	13,737	586	5,186	178,807	662
	Jedburgh	15	1,720	7,596	1	265	5,007	2,488	15,874	1,923	17,441	1,111	6,321	155,768	923
	Kelso	266	6,099	8,111	57	555	7,009	3,615	16 455	745	13,797	1,278	6,602	143,478	1,679
	Melrose	73	1 301	5,338		179	3,560	1,891	9 890	521	14 252	724	4,071	71,166	831
SELKIRK (not divided)		8	238	3,977		154	2,125	1,300	7,894	1,952	12 007	579	3,659	186,386	323
SHETLAND	Mainland	.	622	5,243		1,650	891	1,041	544	1 233	7,991	1,541	8,930	109,349	93
	North Isles		14	1,203	.	414	123	325	133	494	2 691	913	2,735	31,414	81
STIRLING	Central	555	379	7,467	830	1,195	1,566	3,891	4,137	4,066	17,846	1,926	12,530	39,474	1,055
	Eastern	671	473	6,400	605	823	1,242	4,087	3,070	1,591	15,613	1,247	8,568	6,476	991
	Western	108	22	4,672	35	939	1,103	3,550	3 435	1,507	18,529	1,132	10 472	70,223	886
SUTHERLAND (not divided)		..	399	7,695		1,168	2,796	4,588	5,307	1.555	7 269	2.114	9.684	203,166	743
WIGTOWN	Machars	..	142	10,973	116	324	4,572	5,207	20,785	4,051	28.977	2,535	26.495	67,454	5,039
	Rhins	5	60	18,347		1,092	8,123	2,311	31,958	1.120	15.310	2.929	29,361	51.775	11.612

* To be harvested as corn

† See Note on p. 118.

BOARD OF AGRICULTURE FOR SCOTLAND,
EDINBURGH, *1st December* 1924.

Printed under the authority of HIS MAJESTY'S STATIONERY OFFICE
By J. Skinner & Co., Ltd., Thistle Street, Edinburgh.
(4779.) Wt. 10321/179. 1875. 1.25. J.S.&Co.,Ltd. G.19.

The Scottish
Journal of Agriculture.

VOL. VIII.—NO. 2.] APRIL 1925. PRICE 1s. NET.

THE SETTLEMENT OF SCOTTISH FARMERS IN ESSEX.

PRIMROSE M'CONNELL, B.Sc., F.G.S., F.H.A.S.

A NOTABLE event in the comparatively recent history of British farming has been the transference of a large number of Scottish farmers—principally from the West of Scotland—to the county of Essex. As my father and myself were practically the pioneers of this movement, I have been asked to put on record some of my experiences in connection with it.

Many reasons have been advanced—practical, economic, temperamental, etc.—as to why the incomers succeeded where the native farmers had failed, and looking back on it now after a lapse of forty years, I have come to the conclusion that it was not anything peculiar to Scotsmen that led to their success, because there were crowds of English farmers who came from other parts of England who have done equally well, while half at least of the natives survived.

Essex in the "Eighties."—A few words of explanation regarding the conditions of farming in Essex in the early "Eighties" are necessary. Things boomed in that county for a few years after the Franco-Prussian war, but eventually foreign competition prevailed, and prices got worse and worse until the climax of disaster came in the wet year of 1879. Essex was the premier wheat county, there being probably in those days more acres in wheat per thousand acres of land than anywhere else in the country. When wheat ranged from 60s. to 70s. per quarter and men's wages were 14s. per week farmers did well enough on the average of years, but when prices fell below 30s. (down to 18s. per quarter in some cases I personally know of), then the farmers were absolutely ruined and beaten out. The farms became derelict—absolutely uncultivated—and in scores of cases no attempt was made to do anything with them. A farmer situated about the middle of the county wrote to the *Standard* newspaper that from a hill on his farm he could count 120 farms all vacant and going back to a state of nature; in some cases a labourer occupied the farm-house as "caretaker" only. This state of matters was common all over Essex, and the arable fields were growing weeds and rubbish two to three feet high.

Wheat-growing was a comparatively easy kind of farming, and much of the work could be supervised on horseback, and indeed

"horseback farming" was proverbial. The straw was a valuable bye-product and commanded a ready sale in London, so that in old normal times this method of farming was fairly profitable. It did not involve the use of so much capital per acre as did stock or dairy farming, and the farmers had not so much capital to fall back on to enable them to carry on for a time by trying anything else. It was this inability to try any other kind of farming that, so far as I could see, was the cause of the disappearance of the original farmers. When wheat failed the majority did not know how, or had not the capital, to try any other kind of farming, and this, I think, in a sentence explains the existence of the empty and derelict farms. The incomers, who came from the North and West of England in as great numbers nearly as from Scotland, were largely dairymen with families accustomed to working, and experts in the management of cows. London was at hand and could absorb any amount of milk in those days. The incomers were "men of their hands" to a much greater extent than their predecessors were, indeed men (and women) who really liked hard manual labour. Such people by adopting a different kind of farming were enabled to succeed where the wheat growers failed.

It is a problem that was never solved as to what became of the former tenants of the farms. I remember asking that question when first I went round making a reconnaisance, but no one seemed to know; they simply disappeared.

Introduction to Essex.—Advertisements and notices in the *North British Agriculturist* had called attention to the fact that land was going a-begging in the south, that one could have the choice of a hundred farms—rent free at first—if a tenant would only come and take hold. These reports caught a couple of relatives who preceded me, and while on a long visit to these I became acquainted with the possibilities of the situation, and eventually my father and I settled down in the same neighbourhood on a farm of over 600 acres, which became my home for the next 23 years. The farm was not wholly derelict, as the landlord had kept it going in a sort of way for a couple of years, but some of the fields were running wild, and I had a miniature prairie fire to clear off the growth of rubbish before ploughing up again.

I do not know whether it is a fortunate or unfortunate state of matters, but I have always had an itch for scribbling, and no sooner had I discovered Essex than I sat down to write about it. The articles appeared in the *Ayr Advertiser* describing the Land of Goschen I had found, and the effect of these must have been far-reaching, for scores of Ayrshire men—mostly unknown to me—gradually filtered in and settled down. "Filtering in" is hardly the word, for I heard of cases where they came in bands of half-a-dozen at a time to view the Promised Land.

There must be many hundreds of Scots within the county now, but as already indicated many English farmers from other parts came in large numbers: from Lancashire and the North of England, and quite as many from the West of England, Devon and Cornwall. It is quite impossible to give any figures, or to estimate what proportion of the original farmers or their descendants remain, though half at least of the population must be native.

New Methods.—Where wheat culture had failed the new men were not likely to try this crop, but immediately set about putting the land into temporary (or permanent) pastures and starting a herd of cows for the milk trade. The most of these immigrants had come from dairy farms, so they knew what to do. The chief trouble was converting some of the wooden semi-ruinous sheds into byres, getting men and lads who could milk, and bringing in water. This last was difficult in some cases, for in the olden times a pond or a ditch served the stock and a pump the house, while on the other hand gravitation water was desirable for a dairy. There was therefore a vast amount of bricklaying and carpentering all over the county for many years, and the work of conversion is not finished yet after 40 years of it.

Scotsmen were almost universally used to the 19-years' lease of their farms, while in Essex the yearly agreement was almost universal. The lessor and the lessee came to terms somehow. In my father's case he had a lease of 5 years to begin with, which ran on indefinitely after the expiry of the 5 years by "tacit relocation." Nowadays I would prefer a yearly to a long lease: you can "sit" as long as you like or "go" if tired of it.

An important alteration made in the methods of farming was the introduction of temporary pastures. These were quite unknown previous to the immigration, and the growth of a mixture of several grasses and several clovers together was a matter I personally specialized in, and I think I am right in saying that the first "mixture" hay sent to market in Essex was from my father's farm.

Native Farming.—The Scottish incomers found many things to learn—indeed had to learn their business all over again. The climate was different, being much drier and milder with comparatively little frost and snow, so that young cattle could be wintered outside all the year: milk cows could be turned out during the day all winter: all the crops could be sown in autumn if desired and gave much better results if winter-grown: droughts in summer were more common and the root crop more precarious: mangolds took the place of swedes and turnips as the root crop: and so on with a score of other matters. The rainfall was little over the half on the average compared with the West of Scotland, and this fact in itself was of vast importance and influence. But the incomers found out that many other things were different besides those due to the climate and nature of the country: differences due to methods of working, to differences in the style of implements and to different ideas on various points. Yoking a horse into a cart is a simple enough process, yet it is done in quite a different way from what I for one was used to up north. The cart and the harness are differently made for one thing, while similar differences appear right through all the varieties of work.

We were introduced for the first time to land laid up in ridges or "stetches" as they are known in the country, a method of working land which carried many changes of ideas with it. Ridges or "rigs" were in universal use in the old days in Scotland before draining was introduced, for the purpose of running off the surface water from the arable land. The "thorough" draining of the land

with underground parallel rows of pipetiles removed this water by permitting the soakage downwards of the excess rain water. This worked all right in the majority of cases, but failed more or less on the dense clays of England. I am convinced that our ideas as to the action of drains in the soil is all wrong, or at any rate wrong as regards clay subsoils. I have time after time opened up drains which had been put down in the great era of draining 70 or 80 years ago, and the signs indicated that not a drop of water had ever flowed through the pipes, although the top surface was a swamp every time there was a spell of rain. The water absolutely refused to percolate through the clay any more than if it had been a cofferdam, and as a result the stetches have had to be retained and the excess water removed by surface furrows. Personally I have at various times tried levelling down the stetches and working the land on the flat. I have succeeded where the land had a good natural slope so that the water would drain itself off without furrows, but in other cases I had to go back to the stetches.

There are many disadvantages following on the use of stetches—such, for instance, as the inability to cut across them with a binder in harvest-time, and thus being reduced to cutting two sides of a field only; but on the other hand there are many advantages when once one is used to them. The implements are made to suit: a corn drill just takes a stetch-width (and broadcasting seed is almost unknown), a horsehoe for either corn or roots takes a stetch-width at a time, the roller is jointed in the middle and thus adjusts itself to the slopes of the ridges, and so on with everything else. The horses always walk in the furrows and thus never tread on or poach the ridge of cultivated land between, the surface water runs off quickly and the land dries quickly when the weather becomes suitable for working and long before land on the flat could be touched.

Subsoiling.—It might be inferred that subsoiling these dense London clays would give beneficial results, and some little progress made in this direction has given encouraging results. Subsoiling as a process of improving almost all soils was in great vogue a generation or two ago, and then died away. The reason for this I am convinced was the want of power. You can harness four horses to an implement quite easily and handily, but you cannot hitch on ten horses. Now it wants the latter power to be of any use at the job, and it is only now when tractors and motors are becoming common that there is a possibility of success.

Subsoiling is not required by every piece of land, but in many alleged failures to obtain benefits enquiry has shown that there had not really been subsoiling at all, but a mere scratching of the surface, comparatively speaking. In most soils, even in loose gravelly ones, there has been formed a cake or "pan" of iron oxide or carbonate. In other soils—such as clays—the perpetual passage of the plough at a certain depth plus the treading of the horses has formed a pan of rammed clay through which neither roots nor water can go. In both of these cases the tine of a subsoiler passing below plough depth, and cracking and ripping up the subsoil, can only do good in helping the descent of roots and of surface water and allowing of the æration of material probably laid down in

the Great Ice Age. But it wants power to do this, and here in Essex we have had experiments tried in ploughing 10 inches deep and subsoiling another 10 inches, or 20 inches in all. Several lesser depths have been tried, but it is too soon to speak of results. Such work is beyond the power of horses, and the ploughing engines with winding cables have had to be called in. It is in work of this kind that the tractor will show its greatest usefulness, for experience is showing that the tractor is not displacing horses to any extent at ordinary farm work.

Depth has a good deal to do with the success or failure of the process of subsoiling. If the pan is not broken up the work is of no use, for the making of an open passage downwards would help very much to keep the surface dry by permitting the downward percolation of the water, not to mention other benefits. It would be quite a mistake, however, to think that Essex is all stiff soil though we talk of the "Essex clays." A look at a map of the surface geology will show great areas of other soils, such as the marl of the famous Roothings of Essex, the Bagshot Sands, on which are situated some of the many "heaths," barren gravel such as Epping Forest, and so on. The tendency of those in the know is to avoid the lighter soils and take the heavier ones. The rainfall is the explanation. Light soils burn readily in dry weather; heavy ones carry on; while the heavier ones have as a rule a greater store of fertility in them. I have known of men from the north having to give up a farm with nice working light soil and take to one of a heavier type.

Buildings.—The buildings the first comers found on the farms were an eye-opener. Coming from districts where all sorts of stone were to be had for the picking up, the farmsteads and houses were built of solid stonework with slated roofs. In Essex there is no stone, and brickwork takes its place with tile roofs in some cases, but in farm after farm known to me the buildings are of timber with thatched roofs. Where these are standing plumb they are all right, but they have often settled down on the skew. My own buildings are wholly composed of timber; slates had replaced thatch on the greater part of the roofs some fifty years ago, but I only got rid of the last piece of thatch for corrugated iron some eight years ago. Personally I prefer the timber walls; you can make alterations so readily and easily, while it makes quite comfortable housing for stock. I admit it would not be protection enough with the thermometer at zero, but then the thermometer never reaches zero in this salubrious climate. The older buildings are made of oak framing covered with "weather-boarding" of English elm, but new buildings are now of foreign pine.

Implements.—A look at the implements and methods of using them may be interesting, as these have not varied much in forty years. The plough naturally comes first, and the standard Essex plough is made of wood with cast iron weaning parts, and has not been much altered in a century or two, indeed not since the days of Alfred the Great, a thousand years ago. Naturally we northmen did not like them and tried many others of a modern iron type, and in my own case I was perfectly successful with Ransome's "Newcastle plough," Jack's "Dux" plough and Oliver's

"110 A," and carried on for more than twenty years with these with perfect satisfaction—*on the flat.* It was when I was compelled to put the land into stetches again that I found I had to go back to the old Saxon grubbers to suit the work. There are 8 furrows ploughed in the width of a 7 ft. stetch, and there is no room for wide and deep work—a furrow-slice of 10 inches wide and 7 inches deep, such as I had been accustomed to, is out of the question, and one of 9 inches by 5 inches is the rule.

It ought perhaps to be explained that in the south the arable land is quite distinct from the grass land, *i.e.* the arable is always under the plough and the grass is never touched. The incomers slightly altered this by introducing temporary "seeds," but the main point holds. This meant that ploughs were always used on stubble or fallow land, and their deficiencies did not show up fully until they were put to grass land ploughing. On a stubble if the slice is cut and pushed to the side—even if the grass were not covered in—it did well enough where no hand sowing was done, and the surface harrowed or scarified before the drill deposited the seed. So the old plough still holds sway, although the advent of the tractor plough—which can only do four out of the eight furrows on a stetch—is altering ideas.

All the same there is a difficulty in getting workmen to take to modern ploughs, while even the disk coulters and skims, which would improve the work done by the old tool, are not liked. It must not be forgotten, however, that Essex is the "home of the steam plough"; that long before the days of "agricultural depression" Essex men had invented and perfected this implement, and that to-day it is in full use. As a rule, however, the cultivator is preferred to the plough, and all during the summer the engines are in full employment ripping up grass or corn stubble in preparation for next year's winter corn.

Manures.—One of the surprises the occupation of a new country brought with it was the want of good results from the use of artificial manures. I do not mean to say that no artificials have any effect anywhere, but that much of the manures put on gave negative results. I must, in my time of forty years, have thrown away many hundreds of pounds worth of such. On my original occupation both slag and gas lime worked wonders; on my present holding neither have had the slightest effect, while all others I have tried—including nitrate of soda and sulphate of ammonia—are useless. Indeed, a trial of "ammonia phosphate" on beans did actual harm to the crop. My next adventure in this line is to try nitrate of lime on corn crops, and I am hoping for better results. When we first started farming the natives assured us that on Essex soils manures were of no use, excepting the natural ones of dung and lime in some form—usually gas lime—and they quoted the local proverb that "cast iron was always the best manure." This referred to the custom of frequent ploughings of the fallow break. As many as six ploughings are sometimes given to a bare fallow with other cultivations, and I usually give three or four myself.

Haymaking.—One other great difference that must be mentioned in the practice between north and south is in the method of

haymaking. Forty years ago the hay was all turned in the swathe by hand-rakes, and I remember that my father had to import a dozen rakes from the north as the local rakes could not be used for turning purposes. When dry enough the hay was made up into cocks (quiles), and then the differences appeared. In the north the hay had to be "ricked" up into miniature stacks containing a horse-load—say 12 to 15 cwts.—and allowed to sit for a week or two to get tempered before it was ready for the big stack in the stackyard. Here, in the south, the next process after cocking is to carry the lot bodily and stack it up straight away in "sow-stacks" of say 30 tons each. The difference in the climate enables hay to be stacked safely in the south which would not be fit to "rick" in the north. In connection with carrying the haycocks to the stack (in the same field), I may refer to the use of the sweep-rake. The late Mr. John Speir introduced me to an American tool of this sort, which, however, was no use in this country. It took me two years experimenting to design one that would "go," and at considerable expense, while unfortunately I did not patent my improvements. I understand there are over 20,000 of these in use in England now. The haycocks are simply scooped up as the horses walk along, and a load of 15 to 20 carried up to the elevator at the hay stack. A dry climate favours the work.

The carrying of the hay and the corn to the stackyard is largely done by waggons. Some seventy or eighty years ago John Joseph Mechi was farming at Tiptree Hall in this county, and expounding by speech and pen the improvements and reformations we might adopt in farming. I have a complete set of his publications, and it is astonishing to find we are still advocating the same principles to-day, and apparently have not improved much since his time. One thing he did was to introduce the one-horse Scottish long-bodied cart, and at sales to-day it is quite common to see a "Mechi cart" on offer—a copy of some of the carts of the north.

My father and I brought a set of these with us, but one of the discoveries we made was that none of the native men could build a load on them. I could do it myself because I was trained to their use, but eventually I fixed "ladders" or framework fore and aft so as to make the "bed" to build on as big as that of a waggon, and then the men could use them and called them "the two-wheeled waggons."

The principal objection to a waggon is its height, necessitating a great waste of men's strength in putting up hay or corn. As to the comparative carrying power, a working load of sheaves on a waggon is 360 as against 180 on a cart. A waggon, therefore, brings about a double load every journey, so that one horse work is not so superior in haymaking or harvest time. A waggon again is superior for long journeys, while in carting goods to or from a station two horses in a waggon will easily pull loads of over three tons. On the other hand for ordinary carting—such as manure work—the cart must be used. The carts are large because the two horses of a man's pair are always attached, and it is a terrible job to get the dung out on to the land sometimes. The wet of winter with the absence of frost makes the roads and fields soft,

and these heavy carts with a double-horse load, and wheels with not very wide tyres, make a great hash of things.

Social.—In conclusion a word may be said as to the social side of the matter. It is noticeable that the Scottish element has dropped its brusqueness and clannishness, if it ever had these. A residence of a year or two convinces any reasonable-minded man that the modern English farmer is just as keen and able at his business as his "brither Scot." I have personally come across very many Englishmen who are among the ablest men in farming to be met with north or south. The native population received the immigrants with the greatest friendliness, and I have never seen the slightest jealousy or annoyance exhibited. I have sometimes wondered how a body of Englishmen settling in Scotland in the same way would get on.

The fact ought to be emphasised, of course, that this substitution of an immigrant population for the native-born was not accompanied by any reason for a grievance. The farms were standing idle and empty by the hundred, and the incomers had an open entry, and were naturally welcomed by all the tradesmen and farm workers of every district as they brought capital and work to places that were at a standstill.

I do not know whether it is due to the amalgamation of so many different brands of farmers or not, but from being one of the most backward of counties Essex is now one of the foremost, and is forging ahead. The work of the County Institute is having effect, milk recording is booming, and so on, and thus there are many indications that Essex farmers will weather the bad times if any farmers do, and if they are let alone.

THE RATIONING OF DAIRY COWS.

R. BOUTFLOUR, B.Sc. (Agric.),

Agricultural Officer for the County of Wilts.

ECONOMICAL milk production has received a great deal of attention of late. Following up the aspect of feeding balanced rations according to yield, the writer has endeavoured to go a step further and to draw up a scheme setting out full details of feeding and efficient management.

During the past two years this scheme has been practised on a large number of farms in the county of Wilts, and on the whole the results have been most gratifying.

The system is briefly summarised as follows:—

Balanced Rations.—The subject "Rationing Dairy Cattle" may be considered from four main points of view:—

1. The cow must have a maintenance ration sufficient to keep her in good bodily condition and health.
2. For the production of milk the cow must be fed on balanced foods, these foods containing materials similar

to those found in milk and in the same proportion; also these rations must be fed according to her yield of milk.

3. The foods used must be economic in price, palatable and digestible.
4. The bulk of the ration must not be in excess of the quantity with which the cow can deal, but at the same time be sufficient to satisfy her appetite.

It will be noted then, that the total daily ration of a cow may, on paper, be conveniently divided into two portions :—

1. The maintenance ration.
2. The production ration.

The standards adopted are those drawn up by the National Research Institute in dairying, Reading—

	Digestible Protein.	*Starch Equivalent.*
Maintenance, . .	·8 lbs.	6 –7 lbs.
Production (1 gallon),	·56 lbs.	$2\frac{1}{4}$–$2\frac{1}{2}$ lbs.

Maintenance.—If a plentiful supply of good hay is available, then one of the best rations for maintenance is 21 lbs. hay, varying this amount with the size of the cow. On farms where the quantity of hay is limited, then straw and roots may be introduced to replace part of the hay, substituting 5 lbs. roots and 1 lb. straw for each lb. of hay. For example, an 11 cwt. cow which is neither giving milk nor advanced in calf will maintain her bodily condition, *i.e.* will neither gain nor lose flesh, if she is fed on a ration of about 21 lbs. of good hay per day; this may be taken as the standard for maintenance. This is for an 11 cwt. cow. For every cwt. over 11, add 2 lbs. of hay. Conversely, for a 9 cwt. heifer 17 lbs. of hay would probably be sufficient. It must be clearly understood that it is impossible to lay down any hard and fast rules, as so much depends on the individual, and the standards and examples given are intended merely as a guide to be followed in building up rations. Where hay is limited and straw and roots are available, a suitable maintenance ration would be—14 lbs. hay, 7 lbs. straw, 35 lbs. roots.

It may be noted that one may substitute 1 lb. straw and 5 lbs. roots for 1 lb. hay without any alteration of feeding value. In all these rations the home grown foods are sufficient for maintenance purposes.

Production Ration.—A gallon of milk contains one-third lb. of protein and about 2 lbs. of starch equivalent. It should be remembered that a cow is really a factory for the production of milk, and therefore she must be provided with sufficient raw materials (food) to produce the finished product in the form of milk, plus a slight addition which is used up in the process of manufacture. The production standard is $\frac{1}{2}$ lb. protein and 2–$2\frac{1}{2}$ lb. starch equivalent for each gallon of milk. Thus a cow giving 3 gallons of milk will require three times the quantity stated.

In order to fix the correct ration according to yield, some system of milk recording is absolutely essential, as it is impossible

to gauge either the daily or yearly yield of the cows unless the milk is actually weighed. Systematic recording must, indeed, form the basis for selecting and retaining the best milkers and increasing the average yield and capital value of the herd. Once a cow's daily yield is known, to feed her correctly is a very simple matter. One ½ gallon tin will hold 3½ lbs. of cake and meals (approx.); therefore each cow will receive 1 tin full of food to every gallon of milk produced, the feeder's guide being the daily yield in gallons shown in the chart above each cow's stall.

Order of Feeding.—The concentrates, *i.e.* the cake and meals, should be fed prior to the bulky foods, such as hay, straw, etc., for if the cow is fed first with hay she eats liberally of this and afterwards partakes greedily of the palatable cake and meals, and consequently her stomach is over-loaded. If a cow is underfed she will produce some of the milk from the constituents of her own body, but as this source is limited she loses condition, and consequently the yield of milk is very quickly lowered to the level of the food with which she is supplied. Suitable production rations for 1 gallon of milk are:—

1. 2 parts beans and 1½ parts oats. Feed 3¾ lbs. per gallon of milk yield.
2. 1 part decorticated earthnut cake, 2 parts rice meal, 2 to 4 parts palm kernel. Feed 3½ lbs. per gallon of milk yield.
3. 3½ lbs. coconut cake or palm kernel cake, or same quantity of these mixed.

It will be noted that these last cakes are correctly balanced in themselves.

At present prices, the cost of the production ration should not exceed 4d. per gallon. As an example for the full daily ration of a 3 gallon cow the following may be taken:—

20 lbs. hay. 10½ lbs. of a mixture composed of 1 part decorticated earthnut cake, 2 parts rice meal or oats, 3 parts palm kernel cake.

For heavy milking cows the concentrates must be given at least three times per day to prevent over-taxing digestion at any one period.

Chaff.—Chaffing straw is not recommended, for when this is done, chaff is generally mixed with other foods, and the cow is then not permitted to select for herself either the amount or that portion of the straw which she requires. This freedom of selection is important, as the lower portions of the straw stems are woody in nature and very indigestible.

Roots.—Heavy root feeding should not be indulged in. If roots are fed they should be fed alone, either pulped or whole, and at a time after the cow has cudded her previous feed, so as to allow for a thorough mastication of the dry foods.

Water.—Lack of water is probably more often the limiting factor than incorrect feeding. A plentiful supply for drinking purposes is essential, and if not laid on, cows should be watered at least three times daily, including one watering last thing at night.

Time Table of Feeding.—With the former recommendations in view the following time table is suggested :—

Morning.—Half concentrates, followed by half fodder; then water.

11 *a.m.*—Roots (if any fed).

Afternoon.—Half concentrates, followed by half fodder; then water.

If three times milking is practised, then the feeding should be spread over three meals: morning, noon and evening, say 5 a.m., 1 p.m. and 7 p.m.

Three Times Milking.—It must be borne in mind that heavy milking cows cannot do themselves justice on twice a day milking, particularly in the case of heifers. In herds where three times milking has been adopted, the daily average increase in yield has been anything over ½ gallon per head, and the seasonal rate of fall in yield is halved, the net yearly increase being in the vicinity of 200 gallons per cow or heifer that responds.

Further Points with the Heavy Yielding Cow.—The cow's stomach capacity is limited, and a 6-gallon cow cannot digest her 20 lbs. of hay for maintenance in addition to the production ration, say about 21 lbs. of cake and meals. It is necessary, therefore, to cut down the bulk, which may be done in two ways :—

1. Substitute a mixture of bran and crushed oats for a portion of the hay at the rate of 2 lbs. of the mixture for 4 lbs. hay.
2. Reduce the bulk of the production ration by further concentrating the feed for the last gallons as 2 lbs. linseed cake, 1 lb. maize per gallon. This mixture is also beneficial to the health of the cow.

Mineral Salts.—If a deficiency in the foods is suspected, add a small quantity of a mixture of sterilised steamed bone flour, ground chalk and common salt. It is the care of the individual and attention to details that determines the success or otherwise of any system of feeding. As no two cows are alike in any one respect, it is essential to know the cows and satisfy their individual wants.

Preparation for Lactation Period.—For a long time farmers have been aware that a cow should come down to calve in good condition, yet how often has the reverse been the case, due either to indifference to the importance of this point or from fear of milk fever. The latter is probably the commonest reason for low feeding before calving; yet the writer has not the slightest hesitation in stating that "steaming up" (that is, feeding a balanced production ration of cake and meals before calving) is one of the best preventions of milk fever, provided the precautionary details of the system are strictly observed. Looking at it from a commonsense point of view, one may say that semi-starving a cow before calving, apart from the fallacy of such treatment, almost amounts to cruelty, because surely the period of the latter stages of pregnancy is just the time when any animal requires extra nutrition to nourish its fœtus, and to store up in its own body a reserve

supply of energy that will be drawn upon during and after parturition.

If at time of calving a cow is not in a "fresh" condition, there is a heavy drain upon her constitution and a general weakening of the system, and as a result milk fever often occurs. Another advantage of preparing the cow before calving is that she has been receiving concentrated food all the time and is not suddenly fed on it after calving, with indigestion as a probable result.

It may be mentioned here that the object of "steaming up" is to get the animal not fat but fit. This condition is best illustrated by comparison with the hunter, in which a fat, soft condition is useless from the point of view of stamina, and the proper degree of fitness is attained only by correct corn and hay feeding. Although the view is often expressed that it is necessary to prepare a cow before calving, the method to be adopted has always been left for the feeder to discover for himself. The procedure recommended below is based on the writer's own experience and from that of other practical men, who after fair trial consider it an economical proposition, and one which is likely to increase the average yield of the dairy considerably.

In a recent article in the Journal of the Ministry of Agriculture, the two writers, both of whom follow out the system advocated, state that "steaming up" results in all the cows coming down at calving at least a gallon higher than at any other previous period, and that, if a cow after calving does not attain a yield of 5 gallons a day, it is an exception. The article in question refers to herds of ordinary Shorthorn cattle.

Detailed Points.—Six weeks before the cow or heifer is due to calve commence feeding 2 to 3 lbs. concentrates over and above the ordinary maintenance ration of hay, etc., and gradually increase this quantity to about 5 lbs. three weeks before calving, reaching a maximum of 7 to 8 lbs. a week or so later. The concentrates used should be balanced in protein and starch equivalent as fed for the production of milk, and should be of a laxative nature. This point of laxativeness is most important. Excellent results have been obtained from feeding palm kernal cake (kibbled large), it being a balanced feed and lacking in binding properties. A day or two before parturition ease off the concentrated food and give a suitable purgative such as a dose of ¾ lb. of glauber salts and ½ oz. ginger, and repeat the dose after calving.

After calving the cow should be put on a production ration for 3 gallons, 4 days after calving a 4 gallon, and 7 days after calving a 5 gallon ration. (*Note.*—The feeding of the concentrates at this stage should be distributed over as many meals as possible throughout the day.)

A daily record should be kept, and any increase in milk should be followed very closely by a corresponding increase in the cake and meals slightly over her requirements.

The following results will still further emphasise the importance of preparing a cow for her period of lactation :—

17 heifers were obtained in the open market; those which were bought with calves at foot, having calved in Octo-

ber, averaged 893 gallons for the year ending 30th September.

Those bought as down calvers, and steamed up, calving in December, averaged 1017 gallons for the year ending 30th September.

The above averages for ordinary commercial Shorthorn first-calf heifers are somewhat striking, but to obtain these results they were efficiently rationed and managed and milked 3 times a day.

Milking.—An article of this description would be incomplete unless one touched on the question of milking. Too much stress cannot be laid upon the importance of efficient milking, as nothing will produce poorer results than when this operation is conducted in an indifferent or slovenly manner.

The farmer should classify his milkers into two classes, good and bad, and the latter class should on no account be permitted to milk cattle, or the result will be a decreased yield and a decreased percentage of butter-fat in the milk. The order of milking is also important; the heavy milking cows should be milked first in the morning and last at night, thereby tending to equalise the period between milkings.

One cannot over-emphasise the fact that systematic management and feeding of a herd is essentially dependent on milk recording. Without some system of recording it is impossible to feed according to yield. It enables us to weed out poor milkers, discard the unprofitable cows, and breed only from those whose yield justifies their presence in the dairy-herd. In many cases weekly recording is permissible, but here again, to reach the really high-water mark, *daily* recording is desirable. There is nothing that will lend itself to management more readily than a dairy cow, and, what is more, the financial returns will adequately justify the system.

Results are appended from three of the many herds in Wiltshire that are efficiently managed and rationed:—

Herd A.—34 Shorthorn cows, none bought or sold during the year; average annual yield per cow 1004 gallons. One cow gave 2005 gallons and calved again in a year to the day. The maximum daily yield of this cow through the year was 76 lbs. No roots fed.

Herd B.—11 Friesian cattle, including 3 heifers, averaged 1260 gallons. One heifer gave 1300 gallons. Excluding the heifers, the cows averaged 1363 gallons. Small quantity of roots fed.

Herd C.—Average number of cows kept 35, with an average yield of about 700 gallons. 1923-24 systematically rationed and average raised to 925 gallons, 13 cows giving over the 1000 gallons.

Finally, much depends on the individual attention of the feeder. No two cows being alike in any one respect, it is impossible to lay down any hard and fast rules. One can give only a general guide, which may be modified at the discretion and skill of the stockman to meet local conditions and individual requirements.

PASTURE IMPROVEMENT ON HIGH LAND.

Capt. A. R. M'DOUGAL, Blythe, Lauder.

A FORMER article which appeared in this JOURNAL (Vol. II., pp. 59-62, 1919) advocated ploughing and re-sowing as one of the best ways of improving poor pasture. The next question is that of the best seeds to sow. Since 1914 a series of simple experiments with grasses and clovers has been carried out at Blythe to determine the best seeds to sow on high poor land in Lammermuir for sheep pasture for three years lie and over.

The main points inquired into were:—

1. *Identification at any time.*—This point is vital, as from experience one knows the difficulties of identification, and not many farmers can identify all the grasses, etc. that they sow. Further, they vary so much in different environment that recognition is often very difficult. The first step towards progress is the ability to know what grass one is talking about.
2. *Palatability to different Classes of Stock.*—Probably this in itself is a fairly safe guide to the "feeding value." This was obtained by grazing portions of each plot.
3. *Productivity.*—This was ascertained so far as hay and aftermath was concerned by fencing a portion of each plot off.
4. *Longevity.*
5. *Earliness and Seasonal Variation.*—One bite in April is worth two in summer.
6. *Bottoming Qualities.*—It is important to have the whole ground covered with good grasses and keep out weeds.

The answers to these inquiries have been obtained in two ways: by using small plots with a single grass and clover, and from observations on the fields themselves.

PLOT EXPERIMENTS.

The experimental plots have been sown each spring, except during the war, on a poor—sometimes the worst—bit of a field, at elevations varying from 850 to 1000 feet. This was done because most of the text books (in fact all the older ones) apparently describe the grasses as grown under specially good conditions. Sinclair, the great original authority, was gardener to the Duke of Bedford at Woburn, and described the behaviour of each grass as he knew it, but its probable appearance and behaviour 1000 feet up in Lammermuir is a very different matter. What is wanted is a record of how the plants will stand up to ordinary farming under middling conditions. The plots at Blythe were sown with the single grasses in strips five yards wide one way, and the clovers, etc. sown in strips across them. The whole series of plots was fenced off from stock except a strip about five yards wide across the ends of the grass strips. Sometimes a whole plot was grazed, sometimes half of it. This arrangement allows one to make for each species sown a record of

productivity inside the fence, and a record of its palatability outside. In 1924 there were plots of this type available for observation as follows:—one 10 year old, one 5 year old, one 4 year, two 3 year, all simple plots, and four more complex plots of young grass.

From observations made the following general conclusions have been drawn:—

(*a*) The description and behaviour of the grasses and plants as given in the text books cannot be relied on. Diametrically opposite results were noted here. The lesson from this is that grass and clover knowledge is particular and not general, and that in order to make sure what suits his farm each farmer should experiment for himself.

(*b*) Strain and pedigree are of great importance. We all know the differences in the various varieties of oats, potatoes, etc., and plant accordingly. The same knowledge and care is clearly necessary in dealing with the different forage plants.

Palatability.—Some very marked preferences and dislikes were noted:—

Tall Oat Grass.—Sheep were very fond of this grass, but cattle and horses rejected it.

Cocksfoot.—All stock liked cocksfoot and sheep showed a marked preference for it. A very notable instance of this cropped up by accident. A greyfaced ewe happened to find a hole in the fence round the 4 year old plots, and was inside at times for about a week in the end of May. On going over the plots when we mended the fence, I found that the cocksfoot plot had all been well topped and also that most of the stray cocksfoot plants in other plots had been nibbled down. As far as could be seen, not one of the other ten plots of grass had been bitten at all.

Perennial Ryegrass.—Sheep at all times, except in the earliest stages of growth, rejected this grass, and the plots outside the fence every year stood up almost entirely uneaten either as regards leaf or stem. When eaten it seemed to have been eaten simply in order to get at the clovers. The conclusion firmly driven home, year after year, is that the sheep will not eat ryegrass after Whitsunday, if they can get any other grass, except perhaps agrostis, holcus and such like. Ryegrass aftermath, when young, was eaten fairly well, but not keenly. Horses and cattle, on the contrary, always ate the ryegrass plot down as soon as put in, and if the cattle were in the field always, the ryegrass plot did not stand out as a solid uneaten mass, but was grazed down like the rest. These findings apply to the ordinary strains of ryegrass sold, and one year's trial of a special selected strain shows so far no appreciable difference.

The other grasses sown—tall and meadow fescue, timothy, foxtail, poa trivialis and poa pratensis—were well eaten by all stock.

Crested Dogstail stems were always rejected by all stock, and the leaves also were not keenly eaten.

Hard Fescue was not liked by any stock.

Yarrow was well liked and eaten down by sheep, but cattle did not appear to relish it.

Red Clover seemed to be preferred by sheep, which thrive better on it than on the other clovers and grasses.

Productivity.—Part of the plots was cut for hay and the foggage kept uneaten till late in order to judge as well as possible the total produce under these conditions.

Results were that for the first year tall oat grass and perennial ryegrass were the biggest hay producers, and if aftermath is considered cocksfoot was about equal to these in total produce. After the first year cocksfoot was always first, closely followed by tall fescue and tall oat. Ryegrass was a poor fourth, with timothy gradually improving till in its fourth year it exceeded ryegrass, with meadow fescue just behind it. Finnish foxtail, which was negligible for the first 3 years, in its fourth year exceeded ryegrass in bulk, and is now very leafy and superior to the stalky ryegrass. It is still, however, far inferior to the ordinary indigenous foxtail growing wild at the dyke-backs. The produce of the other grasses—so called, bottom grasses—was negligible throughout on both good and bad land. These were hard fescue, crested dogstail and poa trivialis and pratensis. There is, however, an exception in the ten year old hay field (Hunters Field). This is mostly cocksfoot, ryegrass, timothy and tall fescue. On laying back the taller grasses, however, there was always seen a really thick growth of poa trivialis, with shoots reaching fully half way up the cocksfoot stems. The conclusion seems to be that this grass does badly alone, but succeeds well when mixed. Possibly this may apply to poa pratensis also. The pure plots of these were always hopeless failures and full of weeds. Late red clover, if a good take, is a very big yielder, and exceeds, I think, any of the grasses as a first-year producer, and equals most as a second-year producer.

The order of merit of the four year old plot in 1924 as aftermath on September 1st was:—

(1) Cocksfoot, (2) tall fescue—equal, best; (3) tall oat—tallest, thin in ground; (4) timothy—good; (5) poa pratensis—poor; (6) m. fescue—poor; (7) foxtail—poor; (8) p. rye—very poor; (9) c. dogstail, (10) p. trivialis, (11) hard fescue—negligible.

Amongst other plants, the yarrow was very good; wild white clover, good; late red clover, a few plants growing strongly; ordinary white, *nil*.

In 1923 on second-year grass the foggage results on wet, cold, bad clay were: tall fescue, cocksfoot and meadow fescue first and the others poor.

The general results on hay plots were: cocksfoot, tall fescue, tall oat first, and the others in varying places, but all far behind the first three.

On the poorer high, thin land both as first-year and second-year crops the clovers more than once bulked out more than the grasses. On one second-year plot at 1000 feet in 1923 the hay consisted mostly of clover, with late red best, and alsike and New Zealand white equal second.

On a similar plot on cold clay at 850 feet that year the alsike had died out completely, whilst the other two were very good.

Earliness.—Tall and meadow fescues, tall oat, cocksfoot and ryegrass are the earliest to show growth. Some of the others—poa pratensis, poa trivialis, crested dogstail—turn green as soon or sooner, but they do not actually grow. Foxtail shoots early enough, but for produce it is not early.

Bottoming.—Undoubtedly the best bottom producing grasses were the fescues—tall, and especially meadow fescue. This grass alone invariably showed a good close bottom or sward. Foxtail also made a fair bottom. None of the others could show a good bottom by themselves, and I am now making a fresh series of experiments to see which grasses succeed best in making a good bottom with cocksfoot as the base.

Taking the grasses *seriatim* the results briefly are :—

Cocksfoot.—One of the earliest and biggest producers. The first-year ryegrass is better at cutting, but the aftermath quite eclipses the ryegrass, so that its total first-year produce exceeds ryegrass. Unfortunately it browns easily with frost, but this does not seem to check its growth. I conclude that this grass is the sheep farmer's stand-by in this high district, and should be the dominating grass in all mixtures for over one year. I habitually sow 12 to 15 lbs., and in 1923 on two particularly bad fields I sowed 25 and 20 lbs. respectively, to smother the agrostis if possible. Home-saved seed germinates well, and seed I saved in 1921 and 1923 showed 90 and 92 per cent. germination. All stock are very fond of it. The hay yield has several years touched 3 tons an acre. It is really permanent and the aftermath begins to grow as soon as the hay is cut. Its one fault is that it does not form a bottom by itself, and the question now is which grass and clover goes best with it to form a good close bottom.

Tall Fescue.—A close runner-up of cocksfoot. A shade earlier and does not brown Always first away after cutting. Not so keenly eaten by sheep as cocksfoot, but well eaten. Would be interchangeable with cocksfoot if prices were altered. Meantime, since its seed is twice the size of cocksfoot, it will always be twice as dear per seed even if price per lb. were the same. With cocksfoot usually half the price per lb., tall fescue in quantity is rather too expensive. Apart from price it is a desirable grass, really permanent and worth sowing. The very earliest grass to show growth.

Tall Oat.—A good grass and a big producer in the first year, when it leads the way for hay. Aftermath good. More a hay grass than a pasture one. Liked by sheep, disliked by cattle and horses. A very big seed, four times as big as cocksfoot. This and its price put it out of competition with cocksfoot. A good stayer. Plentiful in ten year old field. Blamed for introducing onion couch grass, but careful investigation of every pure tall oat grass plot has failed to show any onion couch. May be called the substitute for timothy on light land.

Perennial Ryegrass.—Early and good till Whitsunday; thereafter disliked by stock, especially sheep. Poor bottom. Very stalky and poor leafage. An inferior grass for sheep and pasture here. This grass must have deteriorated with cultivation. It

probably began as a good, leafy pasture grass, but by seed-growers' selection it is now a producer of seed instead of pasture. One strong point in its favour is that it can always be depended on to grow. The plots sown in 1919 were sown under such adverse conditions that practically all the grasses sown failed except perennial and italian ryegrass. It is very slow to come away after cutting, and is only eighth on the list for foggage, with an extremely poor, almost negligible quantity of produce. It seems permanent, probably due to self-seeding. In 1923 I sowed ordinary ryegrass against a specially selected late variety, but so far no difference can be detected. Whilst it is prudent to sow this grass as an insurance against a bad take, it is doubtful if it is worth sowing on its merits as a sheep grass.

Timothy.—A good stayer. On a wet, often flooded, portion of a ten year old field it is almost the only survivor of the grasses sown, and it is plentiful all over in the hay, where it makes a fine green mixture amongst the earlier grasses if one is unavoidably late in cutting. Liked by all stock, but is really more a hay grass than a pasture one owing to its manner of growth. In the field it is a poor germinator, as only about 10 per cent. of the seeds sown are represented by plants the following year.

Meadow Fescue.—The best bottom, leaf producer. It can make a close sward alone. In the four year old plot it is as thick as ever, and also in the ten year old plot. Looks like a true perennial. It is not a heavy producer like cocksfoot but it is quite good. More a pasture than a hay plant. It is a very poor seed or stalk producer, which is an advantage for grazing. This often makes one think that it has died out of a field as one does not see its flowering stems. Should be sown freely. It seems as if this would be the best companion for cocksfoot to make a bottom, but this has not yet been proved. Liked by all stock.

Foxtail.—After three years it is a good grass. The Finnish foxtail of commerce is vastly inferior to our indigenous plant. For the first three years Finnish foxtail is negligible in produce. It shoots and flowers in April, but the grazing product is very poor then. In the fourth year it seemed to leap at once into a much more productive plant. Not worth sowing except for very long lies. I am experimenting with pure indigenous hand-gathered foxtail plots against the Finnish seed. A very leafy grass and fair bottom producer. Might accompany cocksfoot, but not proved yet.

Poa Trivialis.—Showed up very poorly in the pure plots and is not worth sowing on its record there. However, as stated previously, it bulked considerably in the ten year old hay. Early, but produce negligible in plots.

Poa Pratensis.—Showed up much better than rough-stalked in the pure plots, and for grazing I should say it was a better grass. Produce negligible on pure plots. Turns green very early.

Crested Dogstail.—Produce poor. Not well eaten, and except as an opponent of agrostis is hardly worth sowing. It seemed in two of the ten year old fields here to be able to combat the agrostis, and if so (which is not quite proved) it would be worth sowing heavily on agrostis infected land. Early green but produce negligible. An aggressive self seeder.

Hard Fescue.—A poor grass. Yield negligible. Not worth sowing except on the worst land where nothing else will grow.

The general conclusion derived from fifteen years' experiments here is that for our poor high land in Lammermuir, cocksfoot should be the foundation of our mixture. The next problem is to find out what grass combines best with it to form a good bottom. To study this in 1923 I sowed down four identical plots on good, very bad, and average land from 850 to 1000 feet with cocksfoot as the base, and strips of various other grasses sown pure across it, and nine different clovers pure across the lot. This gives us ninety different combinations of two grasses and one clover. Included in this are two varieties of ryegrass and cocksfoot. It is too soon to state results, but, after three or four years both grazed and fenced, some conclusion should be available.

Clovers and other Plants.—*Red Clover.*—Ordinary English and Chilian red clover were always abject failures here, and until I tried late flowering strains we never had any red clover at all. The results from strains from Oxfordshire of late red clover sown in 1920 and 1922 were noteworthy. Both as young grass in 1923 and as second year in 1924 it was a solid sheet of red clover which defied all attempts to eat it down. It kept nearly three twins per acre and they throve on it, and afterwards ten Oxford lambs per acre as young grass; as second year it was nearly as good. In the third year it had thinned out a good bit but it was still dominant. In the fourth year fenced plot it was still there but thin and spent. It stood the hard winter of 1923-4 and seems immune to frost. Ordinary red never survived the winter here and is quite worthless. For two years' lie late red is preferable to wild white as its yield is greater and stock thrive better on it, while the price is much less. With a good take such as I got in 1923, it exceeds any grass or clover I ever saw. The great difficulty is to get the proper strain. If after trials one finds a certain lot has done best one naturally tries to get it again. It is then that one finds that the seedsman cannot tell exactly where he got it and cannot really guarantee the same strain again. Late red clover seed, like others, seems to be bought in small lots, bulked and cleaned, and therefore, generally speaking, it is something of a lottery to get the same strain again pure. This will doubtless be remedied, but meantime not half enough attention is paid to isolating and keeping pure the different strains of clovers and seeds generally. In 1923 I sowed pure strips, mixed with grass, of Welsh red, late English red, late American red, and wild red. The results in 1924 in hay were—1st, English red; 2nd, American; 3rd, Welsh; 4th, wild. In aftermath, however, the Welsh was an easy first, the two lates equal and wild last.

Ordinary White Clover.—I found the ordinary white absolutely useless, both English and Canadian. What did grow always died out the first year.

New Zealand White on the contrary gave results very much like wild white and resembles it in many ways. The lots I tried gave almost as good results as wild white.

Wild White.—Trial plots of Kent and a specially selected strain were sown in 1923. So far no difference is visible. The merits of

wild white are too well known to need further comment and it has worked miracles on some land.

Alsike.—The text-books say this thrives best on wet clay soils and pines on dry thin land, but the results here are exactly opposite. It throve splendidly on a high, dry, poor, stony plot at 1100 feet, and as a second year plant it beat all comers except late red. On the clay it beat white the first year, but had died out by the second summer.

Yarrow.—This is a wonderful drought resister. Sheep are fond of it and I think it is good for them. Cattle do not seem to care for it. It is worth sowing ⅛ to ¼ lb. per acre of it, the seed being very small.

Wild Tares.—In 1924 I sowed strips of wild tares (*Vicia sepium* and *sativa*) along with other combinations, which may give interesting results. Also home-saved foxtail against Finnish foxtail. The germination of the tares was 14 per cent. with 83 per cent. hard seeds, the foxtail was 84 per cent. In addition to the above, one is inclined to think that the wild pea (*Lathyrus pratensis*) would repay cultivation. Both the wild pea and wild tares are found growing here on the coldest, stiffest clay, thriving and producing a big bulk of stuff which sheep eat freely. In 1920 the hay in this field was mostly composed of wild peas and tares in many spots.

Home-saved Seed.—Farmers might economise a good deal by saving some of their own natural grass seeds. In 1921 and 1923 there were saved for seed here about 5 acres of cocksfoot mixed hay. It was thrashed in the ordinary mill and sent to a seed merchant to be cleaned. It was dressed down to a pure mixture of 480 lbs. of cocksfoot and ryegrass, which germinated cocksfoot 91 per cent. and ryegrass 92 per cent. Being grown at 800 feet it is probably hardier and more suited to sow here than the best bought seed from better districts or countries.

Field Observations on Survival.

The question as to what percentage of seed survives as plants is of great interest. A botanical examination was made in June 1923 by Dr Smith of an exceptionally good take of young grass on good land here at 850 feet and the results were as follows:—

Fore Field.

Quantitative Analysis of Young Grass. June 1923. Sown April 1922.

Seed Sown.	Lbs per acre.	Seeds per Sq. Foot.	Plants per Sq. Foot now.	Percentage Survival.	Remarks.
				Per cent.	
Per. Rye, Irish	20	92	38	41	Big plants.
Italian Rye	3	14	14	100	...
Cocksfoot, Danish	10	92	34	37	Small plants.
Timothy, Canada	6	140	8	6	...
Mead. Fescue, Danish	4	19	10	53	...
Late Red, English	5	23	18	78	Very big plants.
White, English	2	28	traces	...	Very small.
Crested Dog, Irish	¼	5	4	80	Very small.
	50¼	413	126	30	

As this was an exceptionally good take it may be assumed that results are often perhaps only half or one-third as good as above. An average of 56 Danish experiments gives percentage survival as young grass as follows:—

P. Ryegrass .	51 per cent.	Timothy .	10 per cent.
		Mead. Fescue	24 „
Italian „ .	28 per cent.	Red Clover .	38 „
Cocksfoot .	22 „	White . .	28 „

This field was sown with 20 lbs. perennial ryegrass and 10 lbs. cocksfoot as an experiment against an adjacent field of similar land which got only 10 lbs. perennial ryegrass and 15 lbs. cocksfoot. No comparison was possible, as both fields were quite swamped by the late red clover both as first and second year grass.

Further results on survival and longevity are given below in tabular form of three nine year old fields sown here in 1914.

WHEELBURN. 40 acres. Sown in 1914.

Poor thin land, facing north; 900 to 1100 feet elevation. Botanical analysis after 9 years grazing by sheep. No feeding since 1915 and no manure.

AVERAGE of 10 plots. October 1923.

Name of Seed sown.	Lbs. per acre.	Per Square Foot. Seeds sown in 1914.	Plants in 1923.	Shoots in 1923	Percentages. Plants to Seeds sown.	Shoots to Seeds sown.	Frequency.
					Per cent.	Per cent.	Per cent
Per. Ryegrass . .	6	30	1	3	3	9	10
Cocksfoot . . .	16	160	24	32	15	20	70
Tall Fescue . . . / Mead. Fescue . .	7 / 1	40	15	57	37	142	20
Tall Oat. . . .	7	17	7	17	41	100	20
Timothy. . . .	5	125	4	7	3	6	30
Hard Fescue . . .	½	6	16	66	266	1100	60
Cr. Dogstail . . .	¼	5	38	183	760	3660	60
Poa Triv. . . . / Poa Prat. . . .	½ / ½	50	34	92	68	184	50
L. Red Clover . .	2	10	...	...	...	...	...
White	2	4	...	...	...	...	...
Wild White . . .	1	2	26	109	130	5450	90
Chicory	1	7	...	...	...	...	...
Burnet	1	1	...	...	...	...	...
Yarrow	¼	22	8	10	36	45	30
Sown Plants, Totals .	51	479	173	576	...	...	...
Foxtail	...	...	1	2	...	...	10
Weeds—							
Agrostis . . .	...	...	...	837	...	...	90
Sweet Vernal . .	...	...	...	64	...	...	40
Holcus . . .	...	...	...	50	...	...	70
Other Weeds . .	...	...	...	96	...	...	70
Gross Totals . .	...	...	174	1625	...	...	...

Note.—"Frequency" means percentage of plots in which a species occurs without reference to its numbers, *e.g.* if a plant occurs in 7 out of 10 plots its frequency is 70 per cent.; or one might put it that out of every 10 square feet it occurs in 7.

The percentage of shoots of sown plants to total shoots varied in the different plots from 5 per cent. to as high as 88 per cent. The general average was 37 per cent. Plots with long ungrazed herbage and fibrous surface soil gave the lowest percentages, and the shorter well grazed herbage and consolidated surface soil gave the highest results. It should be noted however that the higher percentages are due to a considerable extent to crested dogstail and hard fescue, two grasses of doubtful value. The poas occurred in patches. It is obvious that agrostis is assuming the mastery. Whether the badly grazed portions cause the agrostis or whether the agrostis causes the bad grazing is debatable; probably both work together. It is satisfactory to note how well cocksfoot, tall fescue and tall oat have stood out. In the case of the poas a very large number of seedlings were present. With poas, hard fescue and crested dogstail self-seeding is, of course, their strong suit. The wild white clover and the yarrow show up much more than the actual figures would lead one to suppose. In 1919 portions of this field were top dressed with 20 per cent. slag at rates varying from 10 cwt. to 30 cwt. per acre. No results were ever visible.

BLYTHESIDE. 41 acres. Sown in 1914.

Thin, sharp, very stony land, facing south; 700 feet elevation. Grazed by sheep, and at times cattle as well. Fed in 1915 and 1916. Sheep run off from turnips on to it in 1919. No manure.

AVERAGE of 8 plots. October 1923.

Name of Seed sown.	Lbs per acre.	Per Square Foot.			Percentages.		
		Seeds sown in 1914.	Plants in 1923.	Shoots in 1923.	Plants to Seeds sown.	Shoots to Seeds sown.	Frequency.
					Per cent.	Per cent	Per cent
Italian Ryegrass	6	30	...	...	...	...	...
Per. Ryegrass	8	40	11	45	27	112	37
Cocksfoot	12	120	14	25	12	21	62
Tall Fescue Mead. Fescue	3 1	20	3	11	15	55	12
Tall Oat	5	12	...	...	...	...	...
Timothy	4	100	9	28	9	28	37
Hard Fescue	1	125	36	50	29	40	62
Crested Dogstail	¼	5	334	413	6680	8,260	75
Poa Triv.	1	55	266	469	483	853	100
Poa Prat. L. Red Clover	... 3	15	...	...	...	...	...
White	2	35	...	...	...	...	...
Wild White	¼	5	100	569	2000	11,380	100
Kidney Vetch	2	10	...	...	...	...	...
Sown Plants, Totals	48½	572	773	1610	...	...	...
Weeds—							
Agrostis	...	...	3	12	...	...	12
Holcus	...	...	58	120	...	...	62
Couch	...	...	2	3	...	...	12
M. E. Chickweed	...	...	11	...	...	...	25
Buttercup	...	...	2	...	...	...	12
Gross Totals	...	...	849	1745	...	...	...

Note.—The wild white clover plants is an estimate, as it was impossible to say what was a plant or not. The rosettes were counted as shoots.

The percentage of sown plants to the total is 91 per cent. The agrostis is completely in check, probably owing to better soil and climate and to different treatment in grazing. Owing to the constant grazing the bigger hay grasses are decreasing, but they are still quite well represented. Tall oat has been grazed out. Again the great self-seeders, crested dogstail and poa trivialis, are in the ascendant. Perhaps there may be something in the idea that these in plenty can hold agrostis in check in certain conditions, although this never was a bad field for agrostis in the past. Self-seeding probably accounts for the good show of perennial ryegrass also.

HUNTERS FIELD. 31 acres. Sown in 1914.

Good land, facing south ; 700 feet elevation. Grazed by sheep and fed for the first two years. Hayed ever since 1917. Top dressed every year except 1921, with supers, sulphate of ammonia and in 1923 with potash as well. Very heavy hay crops and foggage grazed.

AVERAGE of 11 plots. October 1923.

Name of Seed sown.	Lbs. per acre.	Per Square Foot.			Percentages		
		Seeds sown in 1914.	Plants in 1923.	Shoots in 1923.	Plants to Seeds sown.	Shoots to Seeds sown	Frequency.
					Per cent	Per cent	Per cent
Italian Ryegrass	6	30	. .	...	...	...	...
Per. Ryegrass	8	40	22	183	55	137	64
Cocksfoot	12½	125	39	87	31	70	100
Tall Fescue	3	20	17	36	85	180	55
Mead. Fescue	1						
Tall Oat	5	12	2	5	16	41	20
Timothy	6	150	20	48	13	32	82
Hard Fescue	1	125	10	26	8	21	33
Cr. Dogstail	¼	5	90	197	1800	3940	73
Poa Triv.	1	55	200	668	363	1214	91
Late Red Clover	4	20	...	...	...	...	...
White Clover	2	35	...	...	...	...	...
Wild White	½	9	24	109	266	1211	82
Totals	50¼	626	424	1359	...	...	...
Weeds—							
Daisy	...	...	6	6	...	...	45
Buttercup	...	...	7	7	...	...	33
Couch Grass	...	...	2	2	...	...	20
Holcus	...	...	11	23	...	...	9
Others—							
Sheeps Fescue	...	...	2	3	...	...	9
Foxtail	...	...	1	1	...	...	9
Gross Totals	...	...	453	1401	...	...	...

The percentage of sown plants to the total is 93 per cent.

Influence of Soil and Time of cutting Hay.—This field was roughly divided into clay land and sharper land, and one portion was always cut for hay about 10 to 14 days after the other. The plots when classified out give the following *Frequency Analysis*:—

Name of Grass.	Clay Plots.	Sharper Plots.	Early Cut Plots.	Late Cut Plots.	Conclusions.
	Per cent.	Per cent.	Per cent.	Per cent.	
Per. Ryegrass .	100	33	43	100	Favoured by clay soil and late cutting.
Cocksfoot . .	...	...	...	...	Present on all plots. No conclusion. Indifferent.
Timothy . .	80	83	100	50	Indifferent to soil. Favoured by early cutting.
Tall Fescue .	40	66	71	25	Favoured by sharper land and by early cutting.
Tall Oat . .	...	...	...	...	Too few details to draw conclusions.
Poa trivialis .	...	...	...	...	On all plots except one. No conclusion. Indifferent.
Cr. Dogstail .	60	83	71	75	Rather favoured by sharper land.
Wild White .	60	100	100	50	Favoured by sharper land and early cutting.
Daisy . .	60	33	43	50	Favoured by clay.
Buttercup . .	20	50	57	0	Favoured by sharper land and early cutting. Killed by late cutting.

Practically everything suffered from late cutting except perennial ryegrass, which made progress at the expense of the others by self-seeding.

Number of Shoots per Plant.

Name of Grass.	Average Number of Shoots per Plant on				Conclusions.
	Clay Plots.	Sharper Plots.	Early Cut Plots.	Late Cut Plots.	
	Per cent.	Per cent.	Per cent.	Per cent.	
Per. Ryegrass .	8·6	2·2	*22·0	4·4	Increase of shoots on clay and early cut.
Cocksfoot . .	2·0	2·4	2·5	1·5	Increase on sharper land and on early cut.
Timothy . .	2·0	2·6	2·4	2·0	Do. do.
Fescue, Tall and Meadow.	2·7	2·1	2·3	1·0	Increase on clay and early cut, like ryegrass.

* This 22 % is largely the result of two very large plants with 66 and 50 shoots on one plot.

Number of Shoots per square foot.

Name of Grass.	Clay Plots.	Sharper Plots.	Early Cut Plots.	Late Cut Plots.	Conclusions.
Poa trivialis .	585	738	909	252	Increase on clay. Great increase after early cutting.
Cr. Dogstail .	180	216	162	270	Some increase on late cut plots.
Wild White .	117	99	117	90	Not much variation.

It is interesting to compare the survival percentages in these three fields with the result of the Danish experiments.

The Danish figures are for the *third* year's grass. Our figures are for the *ninth* year's grass.

Number of Plants per square foot.

Name of Grass.	Danish.	Wheelburn.	Danish.	Blytheside.	Danish.	Hunters Field.
Per. Ryegrass . .	9	1	12	11	12	22
Cocksfoot . .	28	24	20	14	21	38
Timothy . . .	8	4	6	9	9	20
Tall Oat . . .	4	7	3	...	3	2
Fescue, Tall and Meadow . .	8	15	4	3	4	17

It will be noted that in Hunters Field the figures for our ninth year's grass are better than the Danish for three year's grass. This is undoubtedly the result of plenty of manure and haying.

Wheelburn, with the worst treatment and climate, shows the worst results; Blytheside, with better treatment, shows fair results; and Hunters Field, with good land and very good treatment, shows very good results. This demonstrates that the after treatment and soil of grass land has a great effect on its botanical constitution.

Tall oat and wild white show poorly in the figures for Hunters Field compared with their appearance. Looking at the field in hay one saw a lot of tall oat. Its high stems probably made it conspicuous.

The manuring of Hunters Field with about 1 cwt. sulph. ammonia annually, with minerals, apparently exercised very little deterrent effect on the wild white clover, considering the very heavy hay crops grown.

Ryegrass has held its own by self-seeding, as has cocksfoot also in Hunters Field.

Of all the problems that the pasture improver on bad land wants to solve, one of the greatest is to find some means of combating and exterminating the agrostis. Lime seems to help, and from my experience it certainly has either lessened the agrostis or made it more palatable. It would be cheaper, however, if one could find some palatable plant which would crowd out the agrostis on the sour land on which it flourishes. On land with a moor-band pan on it I have so far failed to eliminate agrostis, which eventually takes almost complete possession and which no animals will eat. On better land crested dogstail and the poas seem to occupy the land instead of it to some extent. Wild white also seems helpful, as it entices stock to eat the pasture down and that keeps the agrostis in check. On good land there should, of course, be no agrostis to fight. Heavy stocking with cattle in early summer will keep it down and will improve the pasture greatly on fair land.

As regards top dressing pastures with slag and potash my experience has been disappointing. Since 1902 I have experimented off and on with these manures separately and combined, and in no case have I ever been able to notice any improvement, even with very heavy dressings. This refers to what one could see only, and it is, of course, possible that the "mutton test" might have shown an improvement. At Boon, only 3 miles away, but on a very different soil and subsoil, the application of slag showed

a marked improvement in the "mutton test" over the other plots (*vide* H. and A. S. Transactions, 1905-8-11). Generally, however, throughout Lammermuir the experience of those who have top-dressed with slag is similar to mine, in that no *visible* difference could be detected. Lime, on the other hand, always showed an improvement. I have, however, noticed exceptionally fine grass follow after turnips which had been heavily manured with low grade slag.

In conclusion I would like to acknowledge the great help rendered by Dr W. G. Smith, who did the botanical analyses, and to the late Mr Robert Dickinson, Longcroft, who first suggested and carried out similar experiments.

AGRICULTURAL EDUCATION AND RESEARCH:

Some Economic Considerations.

A. W. ASHBY, M.A. (Hon.),
Agricultural Economics Department, University College of Wales, Aberystwyth.

SINCE the public revenue, both national and local, is the main source of funds devoted to agricultural education, research and advisory work, it is important to consider the reasons that may justify the present or greater expenditure. If facilities for research in pure and applied sciences connected with the art of farming were regarded solely as a part of the nation's general investment in research, or those for agricultural education merely as a part of the nation's general educational system, no special thought need be given to the matter. The reasons for which the nation invests in research or education for industrial development or for cultural purposes would apply equally to all its expenditure, whether for agriculture or other special industries or for general purposes. And in some respects agricultural education is a part of the general educational system, for the nation could scarcely afford to be without it, even apart from whatever influence it may have upon the development of our native farming. A very considerable proportion of the students of agricultural colleges become technicians in agriculture or forestry, or land administrators in the many parts of the British Dominions and connected territories. Without the service of such persons the economic development of the territories of the Commonwealth could not effectively proceed.

There are also cultural grounds on which the supply of facilities for research and study in agricultural subjects may be justified quite apart from their influence on the economy of production. The phenomena related to the art of farming are all part of the natural environment of human beings and societies. They are as worthy of study as the changes of the stars or the tides of the sea; they may even be quite as wonderful, and they may have as great or as little immediate economic import. While we wish to understand our environment, even though understanding may not

immediately lead to modification or control, and while we have to pay for its study, we may in many ways as well study soil bacteriology or helminthology as archeology or the geography of the Arctic regions. We may certainly just as well pay for the teaching of one as of the other.

Just as there is much research in pure sciences related to agriculture that has no immediate economic importance, there is also much agricultural education that has no immediate economic effect on the industry at large; important as it may be, even financially, to the persons receiving this education. The teaching of agriculture that has most direct relation to the practice of the art of farming is that of the "short-course" type. Many students in degree courses in agricultural colleges or university departments have no connection whatever with the industry in later life. Others become teachers or demonstrators, administrators or organisers in various relations to the actual industry, but have no direct responsibility for its practice. Only a minority of degree students have hitherto actually undertaken control of land in their later lives. But to all those who are immediately or indirectly connected with the industry the education received is of financial benefit, though general benefit to agriculture may be small or great according to the services they render. Even the students who do not afterwards engage in any kind of agricultural work may gain considerable personal advantages in agricultural courses, for some courses of this kind provide as good education—certainly as good intellectual training—as other courses that might be taken in similar institutions. And on general educational considerations the provision of agricultural education needs no special justification.

But the justification of expenditure on agricultural education and research has usually been sought on quite different grounds. When money is required it is frequently argued, implicitly or explicitly, that further research or education will enable the agriculturists to secure greater economies in production. In recent years a notion has been current, firmly held and fairly clearly expressed, that further facilities for research and education would enable agriculturists to secure such economies in production as would enable them to obtain greater real incomes. The distinction here is important, for it is not every economy practised in production which raises the financial position of the industrial group concerned. Some economies, some new power of regulation or control, or some new method of production may cause increases in the products until the market may be depressed and the income of the industrial group concerned may be lower than before. But even in this case, society as a whole eventually benefits by being able to obtain the goods it requires by less expenditure of effort. Thus agricultural research and education may be justified if it yields knowledge leading to any greater control of environment which enables society as a whole to obtain its food and raw materials with less effort or greater certainty, even though it does not improve the financial position or directly raise the real incomes of the agricultural producers. Some persons who have supported the extension of special facilities for research or education in agricultural subjects have quite clearly seen this social justification of

public expenditure. They also realise that the agricultural group obtains some benefit through the greater possibility of raising the general standard of life, even though the relative financial position of the group may not be changed. Expenditure on agricultural research and education can be amply justified on the grounds of cultural value obtained through the knowledge of environment, and on those of the social economy secured through the possibilities of obtaining products with less effort and more certainty. To what extent it can be justified on the ground that knowledge applied in production will raise the relative financial position of the agricultural producers has never been quite clear.

The question, however, is one of fact and not in any sense normative. To find a complete answer it would be necessary to range over many countries, where varied natural and economic conditions occur. But it is immediately necessary to consider only conditions in commercial countries into which foodstuffs and raw materials are imported, or from which they are exported, and particularly to consider the conditions in an importing country. It may be said quite definitely that in a country that is completely and solely self-supporting, being neither an importer nor an exporter, the economic advantage of every advance of knowledge leading to greater economy or greater control of production is likely to pass at once to the community as a whole. The agricultural group would proportionally benefit with the rest of the community through the greater possibilities of life and personal development, but it could only retain more than its proportionate share of the advantage if it were in such a political position as would enable it to exercise monopoly privileges. In either an importing or an exporting country the conditions are quite different.

The import or export of food not only assumes but is based upon competition. It is not necessary to stay to consider how far competition is free or how fettered by political impediments, for all the schemes of politicians and all the statutory laws of statesmen are breached by the economic law of "comparative costs." But it is necessary to state that the supply of knowledge which leads to economies in production may itself afford a measure of protection if exercised by an importing country, or may be a means of assisting products to pass over natural barriers, or even over political barriers like tariffs, if exercised by an exporting country. These are the fundamental facts in the consideration of the financial value of agricultural research and education to the farmers of Great Britain. As human beings and citizens they, like other persons, are interested in the cultural value of all knowledge. They may be interested more intensely in the cultural value of knowledge in the sciences related to soils, climate, plants and domesticated animals and conditions of growth of these, in that it is directly explanatory of their immediate environment. They are also interested in the social economies which new knowledge may make possible because they share in the general advances of material civilisation. Whether they are peculiarly interested as producers and sellers of foodstuffs and raw material will entirely depend upon the economic conditions of production and sale and largely upon

the amount of competition, particularly import competition, in the markets for the goods which they produce.

The general position as to the distribution of the benefit of new knowledge which can be economically applied in production may be stated in these broad propositions:—

(1) While competition exists the economic advantage of new knowledge which can be applied in the arts of production will always be shared between producers and consumers.

(2) When new knowledge is obtained which makes possible economies in production in an exporting country, the benefit will be distributed between the producers and consumers in that country and consumers in importing countries. The producers will have an advantage over their competitors, whether of other exporting countries or of the importing countries. They will be able to obtain more profit at prices previously ruling, or to offer at lower prices and obtain a greater share of the trade. Competition amongst individual export producers will tend to greater production and selling, and to the establishment of slightly lower prices to consumers in their own country, and in less degree to the consumers in the importing countries. The relative benefit to the consumers of the exporting country and the importing country will be controlled by the strength of the import demand. With keen competition in selling by the export producers, the main part of the benefit will soon pass to the consumers.

(3) When an exporting country is enabled, by gaining new knowledge, to produce more cheaply, the producers in the importing country are placed at a disadvantage relative to their previous position.

(4) When the producers in an importing country can produce more cheaply by new knowledge they improve their relative position, but the amount of benefit that will be retained by producers and the amount that will pass to consumers will depend upon the proportions of home production and imports to total consumers' requirements.

Some implications of those broad propositions with regard to the production of particular commodities in Great Britain may be discussed later. But it may be said that where home products have to compete with imports, the study of pure and applied sciences applied to production will be of financial value to producers whenever their competitors have been enabled to advance their knowledge and apply it economically. That is to say, it will be of benefit when the home producers of an importing country are enabled to remove a disadvantage. Under such conditions new knowledge will also be of economic value to the nation at large in that it will make possible the retention of production which would otherwise be in danger.

But in any case, knowledge passes quickly between scientists even if it passes slowly between farmers; and while it is true that

the problems of production are not always the same in all the countries competing for the trade in any commodity, the principles underlying the solution of problems are often similar. Under modern conditions it is doubtful whether the producers of any country, either importing or exporting, can long retain an initial advantage which they may gain by applying new knowledge. To retain a permanent advantage from this cause it would be necessary to make constant and continued progress in knowledge and its application in advance of competitors. This applies equally to producers in importing and to those in exporting countries.

There is one good contemporary example of "the knowledge which is power" removing, or at present assisting to remove, the disability suffered by an importing country as against some exporting countries. Sir Rowland Biffen's "strong" wheats are helping to remove the discount against British wheat in the markets of our own country. If eventually these wheats, when grown under all the conditions under which British wheats are grown, prove to give a yield as high as the "weak" varieties previously grown, the difference in price between British and some imported wheats due to the quality of strength will disappear, and if the quality of these wheats could be retained while higher yielding powers are secured, the British producers would then be given some advantage over their competitors. How long such an advantage might continue would entirely depend upon the ability of Sir Rowland Biffen's botanical competitors to develop in their own strong wheats a capacity for higher yields. From the origin of Biffen's stocks it appears that this might not be an impossible or even a lengthy process.

This example may be used to illustrate some other factors in the determination of the financial value of the results of scientific research to the farmer *per se*. It is frequently stated that bread (the chief product of the wheats of the markets) is sold as dear in American or Canadian towns as in London or dearer. This may be true, but it is sometimes difficult to obtain a fair comparison of "values" or "qualities" of bread sold and prices charged even in different parts of the United Kingdom. Assuming that prices in London and New York are equal for breads of approximately the same quality, there must be some factor balancing the cost of transporting the American wheat to London. It cannot be the proportion of the cheaper English wheat that enters into the London loaf, for that is altogether too small to affect the price of a sack of flour from which 94 loaves may be made. When 3½ cwt. of wheat are required to make a sack (280 lb.) of flour and five-sixths "hard" American and one-sixth British are used and the difference in price is 1s. a cwt., there is only a difference of 7d. on the 3½ cwt. between using all American and using five-sixths American with one-sixth English. This small difference does not balance the transport and other costs of bringing wheat to this country. Another possible difference is that of the relative costs of milling, baking and delivery of bread in America and in this country. Allowance must always be made for the middleman's charges, be he manufacturer or mere distributor; sometimes profits accrue to him merely through

changes in knowledge and in methods of production. It was stated above (2 and 4) that under certain conditions of competition the benefit of new knowledge leading to more economical production tends to pass to the consumer. There is always, however, a possibility that a middleman or middlemen may intercept it. This may be true even when there is keen competition of producers in selling and because there is no keen competition of merchants in buying. This was the case in earlier days with "Yeoman" wheat. As the Linlithgow Committee stated:[1] "The merchants and millers have not helped its extension by offering a special price for it," and "the greatest obstacle to the spread of 'Yeoman' wheat has been the reluctance of the country miller and consequently of the corn merchant to recognise its value or to pay for it adequately."[1]

Although the position of the middleman taking the advantage that arises in production may be reached at any time in respect of a commodity, it does not necessarily mean that new knowledge has enabled the middleman to retain an undue profit, but may merely mean that in the previous condition of the market the middleman was working on a margin insufficient to maintain him indefinitely. The middleman does sometimes work on a narrow margin, especially when costs of production are high relatively to the consumers' valuation of a commodity. New knowledge and more economical production may enable him to adjust his margin without the restriction of production that would have occurred had he increased the margin while the old conditions prevailed. It is also true that more economical production may enable the middleman permanently to secure greater profits, but this depends upon the amount of competition between middlemen for the trade that is to be done. Thus the strength of the middlemen's position (be they manufacturers or traders or both) must always be taken into account when considering the distribution of the benefit of new processes in primary production between primary producer and consumer. In the broad propositions above it has been assumed, and quite fairly, that the middlemen will generally benefit with the rest of the community as consumers and that no special benefit will remain with them; but at any given time and with any commodity the position may be quite different. Not all changes in prices are passed forward to the consumer or backwards to the producer, and changes in supply and supply costs or in demand and consumers' valuation may at certain times either enable the middleman to extend his margin or compel him to accept its contraction.

Another assumption inherent in the propositions is to the effect that producers and consumers may both obtain benefit as a result of economies in production, because demands are elastic and consumption will increase as supplies become more plentiful at lower prices. But, as has already been stated, it is possible to glut a market. In the fruit and vegetable trade it is common experience to find that a partial crop may bring greater net returns to producers than a heavy one. This is partly because certain unit costs are fixed without any relation to unit values. A pound of plums selling

[1] Report on Cereals, Cmd. 1971, 1923, pp. 73-74.

at one penny at Covent Garden may cost just as much in railway freight from Kent or Evesham as a pound at another time selling at 4d. or 6d., and it may cost nearly though not quite as much to gather and pack. The salesman charges commission (or percentage) rate or a package rate, according to which may be the higher. The retailer generally requires a higher percentage of margin at the low price than at the higher. When these proportionately higher charges on the cheaper fruit are added to the fixed unit charges for transport (also higher relatively to price), the producer frequently finds that he gets a greater return on a relatively small supply at a high price than on a large supply at a low price But this position arises because the demand is less elastic than the supply, and it is not impossible to conceive the utter bankruptcy of producers of some varieties of plums in the Evesham district if they possessed and applied knowledge that enabled them to obtain complete control of frosts, pests and other obstacles to production and thus to get a bumper crop every year. The clearest and most definite case of this kind is that of hops, for which definite quantitative facts are obtainable. Here the yield per acre is subject to great fluctuations, and in one year may be only half as heavy as in the previous year. In 1908, for instance, 39,000 acres at 12·1 cwt. yielded 471,000 cwt., for which the average price was 55s. per cwt. or a total return of £1,295,250. But in 1909 some 32,500 acres at 6·6 cwt. yielded 214,000 cwt., which fetched an average price of 154s. or a total return of £1,647,800. Again in 1917 some 17,000 acres at 13 cwt. yielded 221,000 cwt. of an average value of 155s. or a total return of £1,712,750, while in 1918 some 15,600 acres at 8·3 cwt. yielded 130,000 cwt. of an average value of 330s. or a total return of £2,145,000. The production of hops is peculiarly subject to various handicaps, particularly of the "pest" character, and if producers were enabled to obtain complete control of pests leading to steady yields they would have to reduce their acreages because of the inelasticity of demand. Other cases of the same kind might be quoted, but there are no other commodities for which such definite facts are available. Fortunately or unfortunately this country could not suffer in the case of the wheat supply because of our large imports, but the inelasticity of the demand for wheat is well known. It may indeed be argued that the demand for wheat ought not to be described as positively elastic. For most elastic demands the correlation between the price and demand curves is negative; in the case of wheat it is positive. If modern support for this statement is required it can be found in the Report of a Committee of the Royal Society who stated: "As a matter of experience it is found that as bread (and other foodstuffs) rise in price, the poor man actually buys more bread than before, because it remains still the cheapest food available to him."[1] And the "poor man" both numerically and per head is the greatest consumer of wheaten bread.

But bad as the immediate effect of a great increase of supplies at lower cost might be for a given group of producers it would be good for consumers. When we know more of the economics of

[1] Report of Food (War) Committee of the Royal Society, March 1917.

consumption than we know at present, we may be able to avoid some of the causes of gluts, which arise partly on the consumers' side. And when producers have enough knowledge to control the forces which oppose production they may have enough knowledge to control their own economic activities, and thus to make easy transition from one stage of production to another.

Cases in which new knowledge will be of temporary disadvantage to a whole group of producers may, however, be expected to be rare or at least of relatively small importance, though in the case of importing and exporting groups concerned with one commodity the advantage of one must, for the time being, be a disadvantage to the other. Under general conditions it is more important to consider the relations between individual competitors when new knowledge becomes available than to consider the position that may arise when knowledge has been applied by a whole group of producers, for it is here that the financial benefit of knowledge leading to economies in production may be retained by farmers. In this connection the most important principle is that agriculture is a competitive industry. Regarded as a group of industries it shows three main forms of competition. The whole group of agricultural industries from market gardening to sheep-farming compete with other types of industry for capital and labour. (The most intensive types, as market gardening or suburban dairying, even compete with other industries for land.) One crop or product competes with another for land, labour and capital; or, as it may be more concretely understood, one type of farming competes with another for the requirements of production. Again one farmer competes with others, even within the group engaged in one type of farming. Often the last two types—the competition between crop and crop (or product and product), and between farmer and farmer—get mixed up and it is difficult to segregate them. But the fact remains that, taking conditions over the whole of the commercial world, agriculture is now one of the most competitive of all industries. Within our own country it is more competitive than it appears to the casual observer. The modern decline of arable farming is only the negative side of a positive competitive movement in the first place between producers of cereals in various countries and then between cereals and milk and meat in this country.

Into this arena of competition the effects of research and education may enter with deadly results to individuals and with disastrous results to groups of men engaged in one type of farming within one country. There is no more striking development in the recent history of British agriculture than the increase in milk production. In part, at least, this increase has been made possible by new knowledge of breeding for milk yield and of feeding. If the milk yield per cow had not increased since 1880, we should now require about 40 per cent. more cows than we maintain to yield the amount of milk at present produced.[1] This would mean that

[1] Estimates of the average annual milk yield per cow between 1879 and 1890 average just over 400 gallons. They vary between 320 gallons (Morton, 1885) and 448 gallons (Turnbull, 1890). The present annual average would not be less than 560 gallons.

milk would cost more to produce, both in food and in labour, and the selling of the quantities of milk now consumed would require that the consumer put upon it a much higher value than he is inclined to do. It is indeed quite safe to say that if the milk yield per cow were now no greater than in 1880 the present quantities of milk could not be sold. In this case the knowledge and practices leading to economies in production were not wholly the products of scientific laboratories. As regards foods and feeding, both scientists and the commercial introducers of new feeding-stuffs have assisted, but the milk yield began to increase before the modern studies of heredity or organised milk-recording began. So far as breeding was responsible for improvement the work was done chiefly by practical breeders.

Very similar considerations apply to beef production, for here breeding for early maturity and better knowledge of the principles of feeding have made possible vast economies. Greater knowledge in this case, however, has only enabled British producers to hold their relative position against others, for, unlike milk, beef is subject to competition of imports.

But in dairy farming the producers have not retained all the economic advantages made possible by the new knowledge. They could not possibly do so, for in the process of increasing their production and extending their markets they had perforce to share the benefit with the consumers. On the other hand the individuals who first began to apply the new knowledge in their practices had very considerable advantages over their individual competitors. This partly accounts for the success of the Scottish farmers who migrated to England to develop dairy-farming on the lands abandoned by cereal farmers. If the increases in the yield of cereals per acre and that in milk yield per cow since 1885 are compared, it is not difficult to find a part of the reasons why milk production was successfully competing for land with other types of farming.

The liquid milk trade, however, was sheltered by the difficulties of overseas transport. The competitors of British farmers were equally, if not more than equally, capable of using all the increasing knowledge of the principles of economical production of milk, and with milk products that would bear transportation they were successful in competition. Could export competitors also have transported milk itself without damage, it is probable that more of the advantage of new knowledge would have been shared with the consumers. There is, however, no doubt that large numbers of individual producers obtained great benefit from the practices made possible by new knowledge before a sufficient number of their competitors to make necessary reductions in prices used the knowledge.

The knowledge of feeding which is now being obtained can be adopted quite easily by the producers of any country. Indeed, there is probably no better illustration of the rapid spread of knowledge than that provided by the dissemination of results of recent research on feeding problems. Individuals who successfully apply it before it is generally applied by their competitors (in this or other countries) may reap the financial benefit; but as soon as

the majority of producers apply it, the advantage must proceed to pass to the consumer. Competition will enforce this, for not only will individuals compete with each other within the group of milk producers or feeders, but the whole of the groups will be competing with farmers of other types for land and labour.

An inference may be drawn that if competition for land and labour occurs, part of the benefit will pass to workers and landowners in the form of wages and rents. In the case of labour this is admitted, and the worker is taken with the farmer as producer. It may be theoretically admitted in the case of landowner and his rents, but it is difficult to find cases of proved increase of rents made possible by economies of production in modern British agriculture. This is partly due to the influence on rents of custom and tradition; and not least to the fact that social feeling and opinion have operated against any attempts that landowners might have made generally to share in the benefits of more economical production. On the other hand, there is not the slightest doubt that improvements in production have saved landowners from suffering large decreases in rents which might otherwise have become necessary during the last half century. It is true that the development of the milk trade alone saved landowners millions of pounds in rents. And generally during the "great depression," advances in methods in live-stock production retarded decreases in rents which otherwise would have been inevitable.

Even in cases in which demand is inelastic, where big increases in production may quickly lead to gluts and low prices, individuals may gain by applying new knowledge, for not all producers will apply it at once. Indeed, it is possible that those who first apply knowledge will obtain sufficient reserves to carry them over the crisis. The whole process has to be viewed from a number of individual cases. At the beginning of the process of application of knowledge the man who can obtain a bumper crop when supplies are low and prices are high has a double advantage. At the other end of the process the man who has yet failed to apply the new method and has a small crop when supplies are plentiful and prices are low suffers a double disadvantage.

Throughout the whole process of applying new methods which research and education may make possible, of increasing production, of increasing competition for land and labour, of increasing pressure to sell, to the time when the latter begins to reduce the price to the consumer, it is the individual rather than the group who gains, though in the case of "sheltered" products (like milk), the group itself can retain some advantages over the other competitors for land. But in the process of applying new methods indicated by scientific research a few adventurous individuals may suffer financially. Knowledge from the laboratory or the experimental plot is not always economically applicable to production under ordinary farm conditions, and requires to be tempered by experience. This was the case even with "Yeoman" wheat, for many growers were sadly disappointed with its yielding quality on their individual farms. They would, indeed, have obtained a greater cash return by growing their ordinary varieties. This is one good reason why scientific workers should be supplied with a farm of

adequate dimensions for the testing of their results. They could not possibly foresee or test the results of their methods or products under all farm conditions, but they could do much of the preliminary testing hitherto done, sometimes at financial loss, by individuals. If it is good for the scientist to see his theories worked out under fairly normal conditions of farming, it is equally good for the farmer that he should not be required to undertake the risk of the testing. And as most of the financial benefit ultimately accrues to the consumer, public support of such testing, equally with scientific research, can be amply justified.

Should competition amongst farmers, either between individuals within the same group or between groups, at any time be restricted, whether by conscious control, by combination, or by the partially unconscious process of raising the standard of living and thus the standard of demand for remuneration, the considerations above would require limitation. But in general it may be said that both the conscious control and the unconscious restriction of supply would rest more securely on such knowledge as leads to certainty of the quantity of produce than on that which leads to increase of yield subject to such fluctuations as occur at present. While world competition exists, however, the conscious control of supplies as such (apart from attempted control of prices) need not seriously be contemplated.

If we wish to retain our production in any branch of farming against international competitors, we have to keep our knowledge of methods of economical production at least equal with theirs. And if we need to stimulate any branch of production, research in applied sciences offers one possible method. But while competitors advance their knowledge, the retention of equality or of advantage requires constant progress in research and its practical application. We cannot hope and we need not fear that the economic benefit of knowledge which can be economically applied in production will be continually retained by producers. Step by step as knowledge is gained and applied the benefit of it will pass to consumers.

THE BIOLOGIST ON THE FARM.—No. XVII.

Professor J. ARTHUR THOMSON, M.A., LL.D.,
University of Aberdeen.

Kemp Fibres in Merino Sheep.—Kemp is a straight, coarse, dull, opaque-white fibre, found mixed with wool, and depreciating the value of the clip in proportion to its abundance. It is often spoken of as "dead, diseased and non-cellular" fibre, but this is not the case. By applying the microscope to the study of the kemp fibres, Professor J. E. Duerden, of Rhodes University College, Grahamstown, and Miss M. Ritchie have been able to give a precise account of the peculiarities in its structure. Kemp has a thick central medulla with hollow interspaces containing inclusions of air. Wool is made up of solid, spindle-shaped, cortical cells, with no medulla and no air inclusions. Hence wool allows

light to pass through as well as to be reflected from the surface, whereas kemp, being opaque in its core, simply reflects the light. Kemp has large external or cuticular cells with feeble serrations, and is non-elastic; wool has small cuticular cells with conspicuous serrations, and is elastic. Kemp grows for only a certain time, and is then shed; wool grows continuously, and is not shed. There is in some South African sheep an occurrence of "kempy" fibres with even thicker medulla than in ordinary kemp, and these are known as "dog-hair" and "gare"; and in general it may be said that the coarser the fibre, the thicker the medulla. It is not the case that the kemp fibres do not dye, but the presence of air in the medulla lessens the effectiveness of the dye. The included air prevents the colour showing in its perfection.

If Professor Duerden and Miss Ritchie are right, there is great biological interest in the occurrence of kemp. It represents the retention of an ancestral hereditary character that has not been bred out. Also the fibres tend to reappear under certain seasonal conditions, just like the large coarse hairs in horses and cattle and some other animals. The wool of the merino represents the under or fur coat of mammals with two coats, the outer having disappeared, except in so far as it is represented by kemp fibres. Under domestication the fine wool fibres have increased greatly in number and in crimpiness, and, instead of being shed, now grow continuously for the lifetime of the sheep. They surpass the kemp fibres, which were originally longer. In the new-born merino lamb there are two distinct coats, an outer coat of coarse fibres on the whole body, but sometimes most noticeable on head, limbs and tail, and an inner coat of fine fibres. This is a recapitulation of ancient history. The two coats of the lamb represent an ancestral stage in the evolution of the merino. The present trend in the domesticated merino is obviously towards further reduction in the number of kemp fibres; and everything indicates that they could soon be got rid of altogether from the fleece, and from the limbs, head and tail were it necessary, by the continued selection of the rams and ewes showing the smallest number of coarse fibres.

Beeswax.—The chemists have been analysing beeswax afresh. It was quite a simple substance, comparatively speaking, when we were at college, but it has become terribly complicated. Its principal constituents are myricyl palmitate and cerotic acid; but there are smaller quantities of myricyl and ceryl alcohols, psyllostearyl alcohol, melissic acid, many hydrocarbons (*e.g.* heptacosane hentreacontane), and unsaturated acids. Yet it does not seem to give the hive-bees much trouble to make all these complexities, for the wax is just a by-product of their chemical treatment of the sugar which they obtain from the nectar of flowers. A number of them take a good meal, and hang themselves up in quiet clusters for twenty-four hours. Then the wax oozes out as a secretion from eight little pockets on the under surface of the posterior part of the body. The secretion hardens into fish-scale-like almost transparent platelets of wax, which become more or less white in colour when the bee chews the material, and in so doing mixes it with air. What, we used to say,

would hive-bees do without wax, for we cannot think of the hive without honeycomb. Yet man has made the bees economise their wax-making energies by giving them artificial cells. This interference repercusses on man, for we read that owing to the bee-keeper's introduction of artificial honeycombs, the European supply of beeswax no longer meets the demand, and large quantities are imported from Africa, the West Indies, and Portugal. But the imported stuff is mostly produced by wild bees, and is inferior to that naturally made in the hive. For it is an interesting biological fact that the different kinds of bees make different kinds of wax. Thus that of the humble-bee is quite different chemically from that made by the hive-bee. This is what is meant by *specificity*.

A Caution.—It is not easy to mislead thoroughly expert ornithologists, for they have attained to great precision of observation. Some years ago we tried one with a single feather and he identified it! But we read the other day an admission made by Joseph Grinnell, a distinguished American naturalist, that he had been recently misled—for a short time at least—by two remarkable specimens (male and female) of the plain titmouse. Both showed on their under surface a vivid yellow instead of the usual ash-grey; and the male was the brighter, as one would from analogy expect. Some other parts of the plumage had a hint of the same bright amber yellow colours. Some naturalists who saw the skins remarked on their "tropical" appearance, and others whispered "mutation." But Mr Grinnell had his suspicions; and an application of the microscope to the feathers showed that they were dusted with very minute elliptical bodies of a yellowish colour. In fact the bright yellow of the plumage, so like a mutation, was extraneous. It was thought at first that the yellowish bodies were pollen grains, but further inquiry made it probable that they were spores of some slime-mould (Myxomycete) which grew in the hole in the tree where the plain titmice snuggled. This has nothing to do with the farm, except that it shows the need for the farmer's caution, which is often very scientific.

An Enigmatical Organ. — Most backboned animals have a paired thymus gland in the region of the neck, which is largest in youth and gradually dwindles. It appears in development in connection with the gill-clefts, and it may be multiple, as is the case in skate and lamprey. In reptiles, birds and mammals, where the gill-clefts have no significance in connection with breathing, the first pair form the Eustachian tubes, running from the outer ear-passage to the back of the mouth; and the second pair are concerned with the development of the thymus. But the function of this thymus is very enigmatical. It has been credited with making white blood corpuscles, and also with producing hormones that influence the reproductive organs and bone formation. But nothing is certain.

A new theory has been put forward recently by Professor Oscar Riddle, who has devoted many years to the study of sex and reproduction in pigeons. He finds that some of his pigeons show a peculiar reproductive disorder that manifests itself in the following ways. The eggs have normal-sized yolks, but are deficient in shell and albumen; there is often only one egg instead of the

normal two; there is a reduction of fertility and the eggs are less hatchable than usual. Yet these birds were quite normal to start with. On dissecting five pigeons affected with the disorder, Professor Riddle found that they had extremely small thymus glands. Moreover he found that the disorder was readily corrected by giving the pigeons some ox thymus along with their food. These two facts taken together suggest that the thymus produces a hormone which has a specific action on the oviduct of birds, affecting the formation of the egg envelopes. What its use may be in male birds is not suggested; and perhaps it has none. The name thymovidin is proposed for the new hormone, but perhaps we should not be in a hurry to name what has not been isolated.

Curly-Leaf in Beets.—In a delightful article on "Nature's Warfare," in the January number of the *Quarterly Review*, Sir Arthur Shipley tells the story of a minute bug or leaf-hopper called Eutettix that is responsible for spreading the disease in American sugar beets known as "curly-leaf." The little beet leaf-hoppers occur in huge numbers, it may be a million to an acre, and they are of course very destructive in sucking the sap of plants. But they do a worse injury in spreading a plant disease. It seems that when one of these leaf-hoppers bites an *infected* beet plant, it sucks up with the sap an ultra-microscopic organism. After 36-48 hours it is able to infect a fresh beet plant, and the disease shows itself in about two weeks. Just as a mosquito carries the ultra-microscopic organism that causes yellow fever, so this Eutettix bug carries the germ of "curly-leaf." It is suspected that other insects are also vehicles of similar plant diseases, as in the case of one of the potato's maladies. In the milky juice of some spurges or Euphorbias there lives a kind of trypanosome allied to the microscopic animal-organisms that cause sleeping sickness and syphilis; and one of the bugs, Stenocephalus by name, is said to be responsible for spreading the infection from one spurge to another.

A Good Hand-Shake.—Within limits one appreciates a good hand-shake, and dislikes a hand like a fish. The organism being a unity, a man reveals something in his hand-shake, and in speaking of intelligence we often use words like grip and grasp. It is no surprise, therefore, to find Mr William Arthur proving by statistical or biometric evidence that there is a positive correlation, of low order, but significant, between strength of grip and each of the three characters—quickness of reaction to sight, quickness of reaction to sound and keenness of vision. In other words, strength of grip is significant; it is not merely a dynamic physical character, it is an index of certain valuable sensory and mental qualities. It goes with the opposite of flabbiness. Why do we "shake" at all? We do not believe the old story that when our forefathers wanted to be friendly they dropped their club and held out their hand—unarmed. Nor do we believe the other extreme view that primitive man was a Freemason. The hand-shake arose from the fundamental fact, now demonstrated by the biometrician (for men at any rate), that grip is correlated with certain good qualities. It gave assurance of these at a time when man was slow of speech. It is an ominous fact that hand-shaking

is going out of fashion; this means an increase of volubility and flabbiness.

Partners of Green Flies.—Leopoldo Vichango, working in the Philippines, has made a fresh study of a puzzle that meets us at home,—the partner-organisms usually found in the Aphids or green-flies which are such a pest on fruit-trees, hops, and many different kinds of plants. As everyone knows, these injurious insects are extremely successful animals, they multiply in prolific abundance in the warmth of summer, reproducing viviparously and without there being any males present. In spite of bad weather, the exigencies of winter, and many enemies, they hold their own; and in genial conditions they become a plague. It is probable that their success owes something to their internal partnership or symbiosis with minute organisms, which seem to be allied to yeast-plants. In a special organ called the "mycetom," these "symbions" multiply, and in the early stages of the development of the egg, whether parthenogenetic or otherwise, they enter the yolk and establish a partnership with the embryo and with successive stages. They are present in every individual; they do no harm; they do not increase beyond a certain limit; they are sheltered and nourished by their hosts, and they seem to confer some vaguely known nutritive benefit in return. They probably produce digestive ferments which are of use to the Aphids, but this remains uncertain. One of the difficulties blocking the way to more precise knowledge is that no one has been able to get them to live in artificial cultures. There are some sceptics who doubt if they are micro-organisms at all, but their life history from egg to adult, and to egg again, as worked out by Vichango and others, is strongly in favour of the idea that they are partner micro-organisms or symbions such as are now known to occur in many other insects.

Witches Brooms.—We came across a birch tree the other day with over two dozen witches brooms. It looked as if there were a rookery on a single tree, for everyone admits the likeness of the witches broom to an old nest. The tangled mass of twigs is, of course, an abnormality of growth; it is provoked by a number of fungi, mostly of the group called Exoasci, which do other things on other trees. The fungi send their threads into the skin of the host-plant, like grass roots growing in a shallow way in the ground. It is very usual for the broom to begin in a bud which has been infected by a spore during the previous summer. In some way not clearly understood, but with its analogies in galls and the like, the irritant presence of the fungus provokes the bud to send out numerous weak twigs. In the course of time there is a crowd of these twigs, many of them dead or half-dead. Spores are produced on the surface of the leaves of the broom and multiple infection occurs. It is interesting to notice that the leaves of the birch broom, which has been well called a "bud-tumour," are much larger than the ordinary leaves of the tree. Thus the presence of the fungoid threads is rather stimulating than destructive. Another interesting point is that it has been found possible to produce a witches broom on an alder tree by artificial infection. In many cases in Nature it is probable that the infection begins by

spores getting into the wounds made by mites. But the most interesting fact is the one we least understand, that the intruding fungus somehow stimulates the birch-tree's living matter to behave in a disorderly way—recalling abnormal growths in man and animals, except that witches brooms are not malignant.

AGRICULTURAL RESEARCH IN SCOTLAND.

ALEXANDER M'CALLUM, M.A., LL.B.

PART II.

ANIMAL DISEASES RESEARCH ASSOCIATION.

As mentioned in a previous article of this series the Board of Agriculture for Scotland in 1918 acceded to a request of the Glasgow Veterinary College for funds to equip a laboratory for work on diseases of sheep. Later, a committee of representatives of the Highland and Agricultural Society, the Scottish Chamber of Agriculture, and the Farmers' Union, after several conferences with the Board of Agriculture, drafted a constitution for an Animal Diseases Research Association, and this was adopted at a public meeting held in the rooms of the Highland and Agricultural Society on 17th March 1920, when the first Directors of the Association were appointed. His Grace the Duke of Buccleuch was made Hon. President, and the late Sir P. Jeffrey Mackie, Bart. of Glenreasdall, Hon. Vice-President; while Mr. Andrew Linton, B Sc., became Chairman of Directors, and Mr. Colin Campbell of Jura, Vice-Chairman.

The aim of the Association was two-fold: research into communicable diseases of farm-stock on the one hand and, on the other, the application of available knowledge to everyday practice. The Association was intended to appeal to the landowner, the stockowner and the stock-attendant alike. Its objects were expected to commend it also to the public; for not only are there enormous yearly losses of farm animals from disease, but the study of animal disease has a very direct bearing upon the problems of human health and disease. It was urged that in order to tackle an undertaking of such scope and importance a close co-operation of the scientific worker, the stockowner and the stock-attendant is essential, both in the investigation of disease and in the adoption of measures of control. Even the knowledge of disease at present available is not applied in practice as it ought to be, and one aim of the Association is to influence the spread of such knowledge and the general adoption of measures of prevention and control.

The Association consists of life members and annual members, the latter including stock-attendants, and the affairs of the Association are administered by a body of directors who are advised in respect of scientific matters by a special committee on which there are representatives of the universities and the veterinary profession.

From the outset the policy of the Association—approved by the Board of Agriculture and the Development Commission—was to secure the services of whole-time workers, who should take up research into the causation and control of diseases which the Advisory Committee and the Directors wished to have investigated, having in view their economic importance. Accordingly in April 1922 Professor Gaiger of the Glasgow Veterinary College and Mr. Dalling, his colleague and assistant in the Sheep Disease Research then being conducted in that institution, were appointed full time investigators. An arrangement was come to with the Directors of the College whereby the investigators continued to work in the specially equipped laboratory in the College until such time as more satisfactory accommodation could be obtained. There the laboratory work is still being carried on, field work being conducted wherever the diseases under investigation are found to be prevalent. A distinct handicap on the work has so far been the lack of accommodation for experimental animals, and the Directors of the Association have considered various sites where land might be obtained and provided with necessary buildings. At length, in March 1924, about 35 acres of land at Moredun, near Edinburgh, was purchased, and plans of buildings to be erected there have been approved by the Government Departments concerned. Building is now proceeding, and a grant of £18,000 has been promised by the Board of Agriculture towards the necessary capital expenditure. In addition, a suite of rooms in the Royal (Dick) Veterinary College has been put at the disposal of the Association, and these will be equipped for the histological and bacteriological work connected with the research.

Mr. Dalling left the service in November 1923 and the staff now consists of the Director, a senior assistant, a junior assistant, four laboratory assistants, and attendants for the laboratories, stores and animals.

Investigation has dealt mainly with sheep diseases, *e.g.*, braxy, trembling or louping-ill, scrapie, joint-ill in lambs, and lamb dysentery; but some work has also been done on mammitis in cows and ewes, the so-called "grass disease" in horses, and distemper of dogs. In the case of braxy, a vaccine prepared from the toxin of what is believed by the investigators to be the causal bacillus has been injected into large numbers of hoggs in braxy infested areas with apparently useful results. The other investigations are mostly at a less advanced stage.

SEED-TESTING STATION OF THE BOARD OF AGRICULTURE FOR SCOTLAND.

Previous to 1914, practice in regard to seed-testing in Scotland was somewhat irregular. Most farmers either relied on their own judgment or upon the knowledge and good faith of the seed merchant. If the farmer wanted a definite analytical test made, he might have this carried through by a private analyst; he might send samples abroad to the established public testing stations on the continent; he might, if he were a member of the Highland and Agricultural Society, consult the Society's botanist, the late Mr.

A. N. M'Alpine; or later, he might apply to one or other of the Agricultural Colleges.

The reports from these different sources were not all made on the same basis, and accordingly it was not easy for the farmer—even when he had a test or analysis made—to check the report against the seedsman's guarantee.

All this was unsatisfactory, and it was to meet a generally expressed desire on the part of farmers' associations that in February 1914 the Board established a seed-testing station in premises at 21 Duke Street, Edinburgh, and put Mr. Thos. Anderson, M.A., B.Sc., in charge.

The functions of the station were defined to be:—

(1) to provide a cheap method of testing seeds, available both to seedsmen and to farmers, and to test tree seeds for landowners and nurserymen;

(2) to obtain information for the Board and for the country as to the quantities of inferior seeds that are being sold.

The numbers of samples dealt with in each seed year are as under:—

1914 - -	364	1918-19 -	8554
1914-15 - -	602	1919-20 -	9451
1915-16 - -	1008	1920-21 -	9964
1916-17 - -	850	1921-22 -	9811
1917-18 - -	5382	1922-23 -	9215

The large increase of samples in 1917-18 was due mainly to the measure of control created by the Testing of Seeds Order, 1917, issued by the Ministry of Food, which came into operation on 1st January 1918. For the purposes of this Order, the Board's seed-testing station became the official control station for Scotland. This Order was merged in the Seeds Act, 1920, and the Seeds (Scotland) Regulations, 1921, which came into operation on 1st August 1921; and the main part of the station's work is now taken up with tests carried out under the provisions contained in the Act and Regulations.

The large increase in the work of the station in 1918 necessitated the provision of additional accommodation, and new premises were leased at 7 Albany Street.

The method of testing first adopted was as follows:—

Purity Tests.—In testing for purity only foreign seeds and foreign matter, such as sand, etc., were treated as impurities. Immature seeds and seeds without a kernel were retained as pure seeds.

Germination Tests.—All seeds of the species to which the sample purported to belong might be included, without reference to their conditions of maturity.

These methods were identical with the practice of the Irish Station, but they differed from those then in use at Continental Stations and by private analysts. They were appropriate to the original function of the station as an advisory agent, but when the change to a control system was instituted, they did not meet the

demands of international trade and had to be modified. Accordingly the Regulations under the Seeds Act define *purity* as analytical purity, and *pure seed* as the seed of which the parcel purports to consist after the impurities have been eliminated; and *impurities* are defined to be all seeds or portions of seeds other than those of which the parcel purports to consist, and also broken seeds of the kind of which the parcel purports to consist so far as they are incapable of germinating, and also foreign matter, such as sand, grit, fragments of roots, etc.

"Percentage of purity" thus means the percentage by weight of pure seed; and "percentage of germination" means the percentage by number of pure seed which germinate during a germination test.

PLANT REGISTRATION STATION OF THE BOARD OF AGRICULTURE FOR SCOTLAND.

For a number of years the necessity had been recognised for some means being taken to test and register distinct varieties of agricultural plants so that it would cease to be possible to market an old variety under a new name to the detriment both of the purchaser of these so-called new varieties and of the breeder of genuine new varieties. In 1917 two deputations from the Highland and Agricultural Society pressed the Board to take action in this direction, and at a Conference held in February 1918, attended by representatives of the societies and trade associations, the principle of establishing a station was approved, and the constitution of a Committee of Management was determined as follows:—

Highland and Agricultural Society, -	3 members.
Scottish Chamber of Agriculture, - -	2 „
National Farmers' Union, - - -	2 „
Scottish Seed Trade Association, - -	4 „
Agricultural Colleges, - - -	3 „
National Association of Corn and Agricultural Merchants, - - -	1 „

At Whitsunday 1920 the Board acquired for the purposes of the station the farm of East Craigs, Corstorphine, extending to 111 acres, but 27 acres of this was resold to the Scottish Society for Research in Plant Breeding, the two stations being thus advantageously associated as neighbours.

The objects of the Plant Testing and Registration Station were stated to be:—

(1) To classify existing varieties of the agricultural plants which are of importance to Scottish agriculture, and to register varieties which are authenticated as novel;

(2) to publish accurate information regarding the type, cropping capacity, immunity from disease, relative merits, etc. of varieties as ascertained by testing;

(3) to carry out comparative tests of special strains of these varieties and so enable the highest standard of production of established varieties to be maintained;

(4) to reduce the number of commercial names descriptive of supposed strains of standard varieties;

(5) to act for the general agricultural community in the settlement of any disputes regarding the authenticity of stocks, and to assist the Board in the administration of the Seeds Act, 1920.

The constitution of the Committee was revised in 1923. The membership was fixed at 24, of whom 15 are representatives of Associations and Institutes, 5 are officials appointed by the Board and 4 are co-opted. The work of the Committee so far has been mainly concerned with potatoes and oats, and two sub-committees deal with these—a Potato Synonym Sub-Committee and a Cereals Sub-Committee. These sub-committees have drawn up schedules of the conditions for the testing and registration of varieties of potatoes and oats respectively.

A guide for the production of new varieties of potatoes has been issued with a view to preventing the submission by breeders of samples of new varieties unlikely to be of commercial value. For purposes of comparison, a complete collection of known varieties has been made. Samples of new varieties submitted for registration are planted both at East Craigs and at the Wart Disease Immunity Trial Station at Philpstoun. Except where samples are found to be (1) obviously of a standard non-immune variety and affected by wart disease at the trial, or (2) of an apparently distinct variety but so affected, they are kept under observation in respect of botanical and other features for at least two years. In order to facilitate the classification according to date of maturity and also to furnish a trustworthy method of estimating yield, the various plots are laid down in quadruplicate on a definite plan and carefully catalogued. A record of observations and of yields is kept for reference.

With regard to oats a preliminary investigation has been carried out of the botanical characters of the common commercial varieties of this country, and of foreign varieties which are believed to have affinities with these. This investigation was carried on for two years, and as many as 66 varieties were grown. The station is now able, from observations made during a growing test, to assign any variety submitted for registration to its botanical group or sub-group, or, alternatively, to state that it is distinct from any variety grown in this country.

Investigation has also been made into the methods of growing plots for estimate of yield, and in this connection the value of parallel plots has been tested.

Work has also been done in investigating the feeding value of turnips and swedes, the station collaborating in this inquiry with the staffs of the Agricultural Colleges, the Rowett Institute and the Plant-Breeding Station.

At present new buildings are in course of construction at East Craigs for the accommodation of both the Seed-Testing Station and the Plant Registration Station.

Advisory Officer Scheme.

Part of the organisation planned by the Development Commission makes provision for a corps of officers attached to Agricultural

Colleges or University Departments of Agriculture whose main duty is the investigation of local problems. These investigators are named—not very happily—Advisory Officers. As applied to Scotland the scheme allows for the appointment of three officers at each of the three Colleges, and it is left to the discretion of each College to choose the lines of investigation to be pursued; the intention being to have the work intimately related to the problems specially affecting the type of agriculture in the College province.

The West of Scotland College have accordingly appointed two officers to deal with problems of dairying—one on milk production problems, and one on those of milk utilisation, and a third in plant pathology. Work has also been carried on for some years in soil study throughout the College area.

The East of Scotland College have appointed two officers: one for bacteriology, and one for work on soils. They propose also to appoint an officer in agricultural botany, but this appointment is meantime delayed.

At the North of Scotland College two lines of investigation have been settled—one on soils and the other on entomological problems, especially bee-keeping.

The Colleges have wisely moved somewhat deliberately in filling these appointments; one reason being the difficulty of obtaining men with the special qualifications required to undertake the duties satisfactorily. The officers ought to be persons who not only possess high scientific knowledge and ability and taste for research, but who also have had considerable experience of practical agriculture, so that they may be able to understand and appreciate the import of their problems from that point of view.

Connected with this scheme, though not formally a part of it, is the arrangement recently made by the Board of Agriculture for the investigation of horticultural problems. The suggestion for work of this kind being undertaken was made to the Board by the Royal Caledonian Horticultural Society, who were anxious that a survey should be conducted and advice made available concerning diseases of fruit trees and bushes and vegetable crops. A mycological investigator has been appointed with headquarters in the Royal Botanic Garden, Edinburgh, where facilities have been provided by the courtesy of Professor Wright Smith, the Regius keeper. The members of the horticultural staffs of the Colleges are co-operating in this investigation, which is to include a survey of the fruit areas in Scotland to be undertaken by the College horticultural lecturers, who are to act also as local advisers. The details of the survey are under consideration.

POULTRY INVESTIGATIONS.

Useful work has been accomplished during the last two years by a Committee of College and Institute workers interested in poultry-rearing. The Committee, the moving spirit in which is Dr. Orr of the Rowett Institute, draws up schemes of experiments to determine, *e.g.*, points in feeding, and the actual experiments are then carried out simultaneously on the poultry stations at Kilmarnock, Edinburgh, Craibstone, the Rowett Institute and

Alness. In this way reliable data are obtained from a much bigger number of birds than could be provided by a single station. The results are discussed by the Committee and published as determined. In this way valuable information has been obtained on the effect both upon growth and upon egg-production of the feeding to fowls of such substances as cod liver oil, fish-meal, yeast, etc., and work is now proceeding on similar lines on the effect of the presence or absence of certain minerals in the food of fowls.

It is gratifying to note also that this work has attracted the notice and brought about the co-operation of the authorities at the Animal Nutrition station at Cambridge and the Department of Agriculture of Northern Ireland.

Committee of Research Workers.

Co-operation in research is not confined to the work in poultry feeding. At the invitation of the Board of Agriculture, the heads of the various stations where work of this kind is being carried out have formed themselves into a Committee which meets at stated intervals to discuss matters of common interest, and to arrange for joint effort in research where this is possible and desirable. Sub-Committees are formed to discuss special lines of work, as *e.g.*, a Field Experiments Sub-Committee; a Soils Sub-Committee; the Poultry Sub-Committee above referred to; a Feeding Experiments Sub-Committee, and a Sub-Committee on Sterility of Farm Animals.

Two annual conferences have been held, the first at Aberdeen, the second at Glasgow, of all those engaged in research together with representatives of the teaching staffs of the Colleges. The two conferences were each attended by about a hundred representatives of these services. Papers were read on work accomplished and discussions took place on topics arising therefrom. Visits were paid to the various stations at the two centres:—the Rowett Institute, the College experimental grounds and farms and Craibstone School at Aberdeen, and the College farm, the horticulture, the poultry, and the bee departments, and the National Dairy School and the Research Department at Kilmarnock. Demonstrations were given of the researches being conducted at the different centres.

In these ways the research workers, the central teaching staffs and the extension staffs have been brought together, knowledge of the lines of work in progress has been disseminated, and a spirit of co-operation has been fostered.

Future Development.

The organisation above described is of much too recent establishment for any considerable bulk of work to have been accomplished or for any certain judgment to be passed on its efficiency. But at all events the machinery has been provided and it promises to work satisfactorily. Improvements and modifications will doubtless be made upon it in course of time and under better financial

conditions. Suggestions have indeed already been put forward for development. Lord Constable's Committee on Agricultural Education and Research in Scotland have urged the more adequate endowment of agricultural research in general, and in particular have strongly supported the claims for additional national expenditure upon research work in animal diseases, plant breeding, and animal nutrition. They recommend also the establishment of a Dairy Research Institute in the West of Scotland, the resumption of work upon agricultural economics, and extension of the work on plant diseases.

These recommendations are indicative of the altered public attitude towards research, and especially agricultural research. Until recently such work was regarded by the agricultural community with at best indifference. But as the scientific worker has steadily advanced the knowledge of natural processes, and as the bearing of new knowledge upon farm practice has come to be appreciated, so the attitude of the public and of the State has changed from apathy to interest and sympathy, and we have come to recognise that under modern conditions the best hope of development for British agriculture lies in the advancement of knowledge through scientific research and the spread of that knowledge among practical farmers. Such is the object of the organisation described in the foregoing series of articles.

NOTE.—*An article descriptive of other research agencies in Scotland appeared in the January issue of the* JOURNAL.

Articles on Agricultural Education were published in issues of the JOURNAL *during* 1923-24.

FARM PESTS—BIRDS.[1]

JAMES RITCHIE, M.A., D.Sc., F.R.S.E.,

Natural History Department, Royal Scottish Museum.

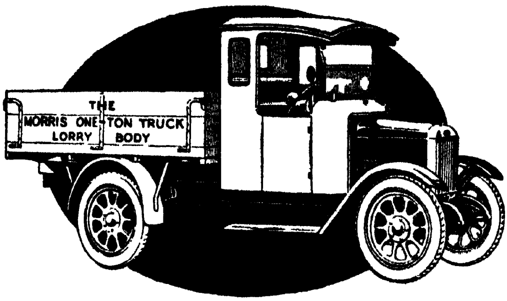
BIRDS AND GRAIN CROPS (*continued*).

The Destruction of the Wood-pigeon.—In natural conditions the control of the wood-pigeon rests largely upon the more active birds of prey, particularly the swift peregrine falcon. But these natural enemies have been reduced by man almost to the vanishing point, and it is not to be wondered at that during the period when this reduction was most pronounced, the increase of wood-pigeons was noted throughout the whole country. In the early years of the nineteenth century the wood-pigeon was regarded as extremely rare in Scotland, but long before the end of the century Thomas Edward of Banff and many others had drawn attention to the menace of its rapidly multiplying numbers. Other factors, however, tended also to the spread of the wood-pigeon, notably the increase of plantations, which afforded suitable nesting sites, and

[1] Articles in this series, dealing with Mammal Pests, commenced in the JOURNAL in July 1922. The first article on Bird Pests appeared in January 1924.

THE MORRIS ONE-TON TRUCK

With LORRY BODY.



Price complete with Lucas Lighting Set, Full Chassis Equipment, and Detachable-sided Body as Illustrated

£225.

Standard Van, £235.

This is a General Service Vehicle, capable of withstanding the roughest usage, and it does its work at the lowest practical cost. Petrol consumption is over 20 miles per gallon.

For Fuller Particulars Consult:—

WESTFIELD AUTOCAR Co., Ltd.,

WESTFIELD AVENUE, GORGIE, EDINBURGH.

Phone: CENTRAL 5420. **Telegrams: MORSERVICE, EDINBURGH.**

If you want to Make Money——

SILAGE is so much cheaper and more valuable than Roots that a Silo will pay for itself in two years. But it must be an

"Ec-onom-ic" Metal Silo

WHICH

Makes the best Silage.
Costs the least for Depreciation and Upkeep.
Is easily Erected and Removed.
Is acknowledged the World's Best Silo.
Is the Cheapest always.
Is made in England.

Write for Free Booklet— BOOKLET "S.A."

THE GEO. H. GASCOIGNE CO., Ltd.,

LYNDFORD HOUSE, - - - - READING.

——Make SILAGE.

the extension of the practice of growing turnips and other green crops, which afforded a winter supply of food.

Nowadays falcons, because of their scarcity, may almost be reckoned out of count as wood-pigeon controllers. The common red squirrel is credited with destroying the eggs and young of the wood-pigeon in the nest, but this destruction also must be regarded as of little practical importance.

Man, therefore, is left to control the pigeon pest single-handed, and he employs several means to achieve his end. In all, however, he is compelled to act warily and skilfully, on account of the shyness, acute senses and active movements of the bird.

Shooting, with or without decoys, is most generally practised, and as it is almost impossible to stalk the birds while they are feeding, a fixed stance is usually chosen. This offers an opportunity of arranging previously some artificial aid to concealment—a rude tent made of sacking or a rough shelter of branches, placed as inconspicuously as the surroundings of the field permit. Since, in such shooting on cropped ground, it is necessary to induce the pigeons to come within easy range of the gun, two devices may be adopted. The first, the planting of a few flags attached to short sticks in the portion of the field remote from the shooter, prevents the birds from settling too far out. The second, the placing of inanimate decoys—whether painted effigies, stuffed skins or dead pigeons—in the neighbourhood of the shooting stance, may induce the birds to land within comfortable shot. The best time for shooting on crop is during the hours of most active feeding, in the early morning or early evening, the height of the day being a period which most birds spend in more leisurely occupations.

Equally common and successful is evening flight shooting, when the birds are picked off as they return to their roosting woods. It is best carried out in a fairly strong wind, which causes the birds to fly low and less warily. The shooter, concealed as far as possible, stations himself during the last hours of daylight on the lee side of the wood, preferably opposite the highest trees, and awaits the incoming birds, which always fly head to wind. Even in the waning light, however, great care must be taken that no incautious movement betrays the shooter to the birds.

On rare occasions trapping pigeons alive has been employed with success, as many as a thousand birds having been taken with one trap in a season. The trap is a large cage, arranged on the tunnel principle, having a falling door at each entrance so adjusted that when the pigeons have ventured within after scattered grain the doors may be released by a watcher and close upon them.

Single-handed shooting of wood-pigeons sometimes results in very considerable slaughter. Mr Hugh S. Gladstone records, among many lesser results (*Record Bags and Shooting Records*, p. 111), a total of 467 thus killed in Ireland in four and a half hours in December 1911, and at Bonar Bridge in Sutherland, on a winter's afternoon, Mr A. M. Chance shot 131 in less than two hours. But when the wood-pigeon is present in large numbers and is proving to be harmful over a wide area, only united and simultaneous action is of much avail. The efficiency of organised destruction has been often illustrated in Scotland. In four years in the late

seventies of last century, on the Seafield estate in Banffshire, a small head-tax resulted in the destruction of 15,194 eggs, 1603 young and 3733 old birds, a total of 20,530. About the same time the East Lothian Agricultural Society offered a penny to twopence a head and a penny for each pair of eggs; in seven years, 130,440 pigeons were accounted for. Even such numbers fell into insignificance beside the result of a country "shoot" in Devonshire in the winter of 1917, when, according to *The Daily Mail* (1st January 1918), 25,000 wood-pigeons were estimated to have been killed in one day.

Wood-pigeons, except in counties where they are specially exempted from the operation of the Wild Birds Protection Act of 1880, may, during the close season from 1st March to 1st August, be killed legally only by owners or occupiers of land or persons authorised by them.

It is hardly necessary to add that almost the only compensation the ringdove offers for its destructiveness is the excellence of its flesh, for which poulterers find a steady demand.

The Stock-Dove.—Only in comparatively recent years can the stock-dove (*Columba œnas*) be said to have projected itself into the list of British agricultural pests. It is a native of Western Asia and Europe, which long since planted outposts in southern England, but which, during the last three-quarters of a century, has been rapidly extending its range northwards in Britain. Previous to 1860 it was unknown in Scotland, and the first nest was not recorded till about 1877. From that time its advance has been rapid, so that it reached Sutherland not later than 1889. The advance has been associated with the planting of colonies in many suitable places, and with a great increase in the number of the birds.

The stock-dove is smaller than the wood-pigeon, its length measuring about 13½ inches against the 16½ inches of the latter, and its wing 8½ inches against 9½ inches. Its colour also distinguishes it, the plumage being greyer, the eyes and feet pale red instead of coral red, and the white on neck and wing, which infallibly marks the ring-dove, being absent.

Further, its habits differ from those of the commoner species. It shows a decided preference for open country instead of woodland, though it may occasionally nest in trees, a practice almost habitually followed on the continent. Many colonies are scattered up and down the coast, amongst sand-dunes and on riddled cliffs, and, inland, sandy banks and pastures offer it suitable nesting sites. The nest is placed in some sort of hollow, in a cliff or a tree, but perhaps most frequently a rabbit's burrow is adopted. The breeding season extends throughout the spring and summer months, a clutch consisting of two almost white eggs.

The damage caused by the stock-dove is similar to that of the wood-pigeon. It feeds upon grain, the juicy leaves of green crops, and the seeds of weeds, such as charlock. In thirty-four specimens examined by Dr W. E. Collinge he could "detect no difference in the nature of the food from that of the wood-pigeon, grain, clover, swede and turnip leaves, beans and peas, being in about the same proportion (*The Food of some British Wild Birds*, p. 68).

Three factors, however, place it as a pest in a somewhat different category from the wood-pigeon. The first, that its numbers are still almost insignificant compared with the wood-pigeon hordes, so that the damage due to it is limited in quantity. The second, that although it is widely distributed throughout the country its colonies are confined to restricted localities, so that its harmfulness also is severely restricted in place. And, third, the seaside colonies, which comprise the bulk of the stock-dove population, feed largely upon the sea-shore.

The Rock-Dove.—Reversing the history of the stock-dove in Britain, the rock-dove (*Columba livia*) ancestor of the breeds of domestic pigeons, has dwindled from being a serious pest to an almost negligible position in British agriculture. Formerly it tenanted the sea-shore cliffs on every coast of Scotland, being particularly abundant where caves afforded suitable shelter and breeding ledges. But the rock-dove had to compete for food with increasing numbers of the more robust wood-pigeon, and man hastened its disappearance by wholesale destruction of its flocks for food, capturing them by simple traps at the entrances of the doo'-caves. Its almost complete desertion of Anglesey and the Isle of Man in England, and in Scotland of Fair Isle, is typical of its fate along the greater part of the coast, and it is only on the west coast and the isles of Scotland that it is abundant.

Other pigeons than the rock-dove, however, frequent sea cliffs, most of them wild descendants of domestic races; but from all, the rock-dove is to be distinguished by its dove-coloured plumage broken by a striking white rump, very noticeable in flight, and by two well-marked dark bands across the wing. Otherwise both in size and coloration it closely resembles the stock-dove.

Like other wild pigeons, the rock-dove shows a predilection for grain and green crops, but it also feeds extensively on weed seeds. Its scarcity in the more highly cultivated areas removes it there from the category of pests, and it is only along the west coast, as in Argyll, whence complaints regarding its depredations have been made to the Board of Agriculture for Scotland, and in the isles, that it does a limited amount of damage.

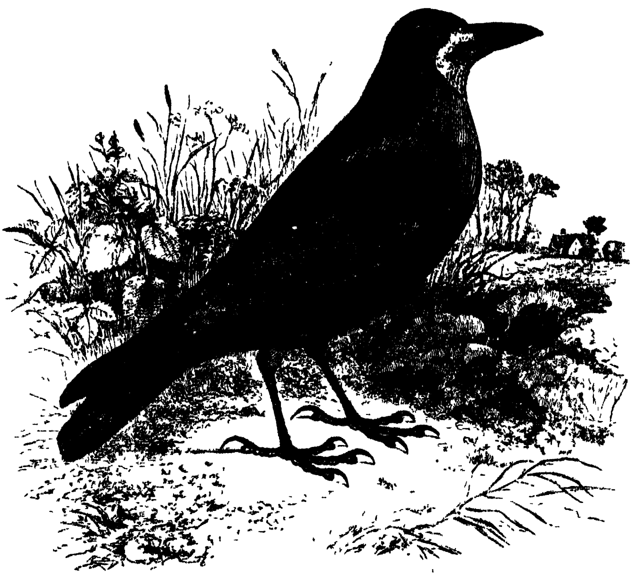
The Crow Family.—Three members of the crow family share some responsibility as regards damage to grain crops, but the responsibility falls lightly upon two. In France the carrion or black crow and the hooded or grey crow are responsible for much destruction in the newly sown fields, where, by digging up the grain and nipping off the young shoots, they may ruin 40 to 50 per cent. of the sowing. They are also reported to pillage the ears in time of snow. But in Britain, although they may feed occasionally with the rooks, no charge of extensive grain damage has been brought against them. It is a different matter with the third, the rook.

The Rook.—Farmers and naturalists alike are agreed that the rook (*Corvus frugilegus*) does damage, and often serious damage, to grain. Did the matter end here, the rook must be utterly condemned; but it is certain that even the rooks which do harm perform also a vast amount of beneficent labour in the fields, and the balancing of the good against the evil has led to much con-

troversy, which even yet has not reached a convincing stage of certainty.

In appearance the rook resembles the carrion crow, but it is slightly less in size, its plumage has a steely blue reflection with little of the greenish gloss which mingles with the purple irridescence of the carrion, it has a slightly longer and more slender bill, and in adult life has a bare featherless patch of rough skin at the base of the bill and on the front of the face—a distinctive head-mark.

The social instincts of the rook are strong. The nests are grouped in colonies of various sizes and the colonists seem to be subject to some sort of understanding which individuals transgress at their own peril. In normal seasons nest-building



THE ROOK.[1]

is seriously begun early in March, the rude nests of twigs and turf, lined with root fibres and straw, being generally placed high in deciduous or coniferous trees. The young, three to six in number, hatched from bluish-green eggs streaked with brown, are fledged and leave the nest in April, although they do not become independent of parental attention for some weeks later. The sociability of the rook is emphasised by its curious winter habit of forsaking the outlying nesting colonies about September and congregating in some dense wood near the centre of the area. This centralisation has the effect of altering to some extent the agricultural incidence of the rook's activities in summer and winter, but the effect is less marked than might be supposed, owing to the fact that the winter roost is the scene of a daily dispersal to the feeding grounds, which may lie at a very

[1] From Saunders' *Manual of British Birds*, by courtesy of Messrs Gurney and Jackson.

considerable distance from the roost. The rooks wintering at Avontoun, Linlithgow, have recently been observed to fly daily to the neighbourhood of Shotts in Lanarkshire, a distance of about 13 miles (*Scottish Naturalist*, 1924, p. 23).

These remarks apply to the resident rook population, but migrations add to the complexity of the rook problem. Thus, although the majority of British nesting birds remain in Britain throughout the winter, some forsake the country for the south in September and October, returning again in February and March. The numbers of these emigrants is, however, much more than compensated by the influx, from September to mid-November, of large numbers of rooks from Central Europe, and of smaller numbers from Northern Europe. These birds remain throughout the winter, leaving our shores in the following spring, from mid-February till mid-April.

Rooks and Grain.—Many charges are laid against the rook, but the burden of the complaints bear upon the grain crop, which suffers at various stages. The most serious damage is undoubtedly done in the newly sown fields, where rooks dig up and devour the grain from the time of sowing until the seed is well sprouted. It has been said that the autumn sowing is less liable to attack than the spring sowing, but this differentiation between spring and autumn sown grain does not appear to be borne out by the statistics collected by Theobald and M'Gowan and published as a special report in a supplement to the *Journal of the Board of Agriculture* in 1916. Here the average number of grains found in the crops of rooks during February, March and April 1912 and 1913 was 18, whereas during September, October and November of the same years the average number was 24. No examination of large numbers of slain rooks, however, is needed to show that at sowing seasons pilfering of grain is common in certain areas. Mr Walter Stewart has recorded (*Scottish Naturalist*, 1924, p. 145) that in south-east Lanarkshire "immense damage is done to the crops during the six months when the birds are in their summer residence, and the ground underneath the nests soon becomes absolutely littered with grain husks in spring and early autumn."

This kind and degree of damage is by no means universal. A great deal depends upon the character of the cultivation in a given district. Thus, although south-east Lanarkshire, containing less than 10 per cent. of the country's arable land, suffers heavily, the grain crops of the north-western section, with over 90 per cent. of the arable land, suffer scarcely at all, yet the number of rooks in each does not differ greatly, the former area containing some 10,330 nests, the latter 8552. The secret of the difference lies in the fact that the north-west section contains much pasture and hay land, which affords an abundant supply of the insect food preferred by the rook, so that the grain crop escapes, whereas the less fertile south-eastern section is deficient in meadow land.

The second vulnerable stage of the corn crop is at the approach of harvest time, when the grain is almost or quite ripe. Then the birds, alighting to feed upon the ears, beat down the stalks with their weight or deliberately by flapping their wings, destroying much more grain than they actually devour. Especially do they

add to the damage caused by wind and rain, for laid or partially laid corn offers them an opportunity which they are not loth to seize.

Lastly, the grain may suffer in stook or even after it has been placed in the rick. In the latter case rooks have been known to pull out the straws in order to obtain the head, and to destroy the thatch to get at the stored grain beneath. Such occurrences, however, must be rare, and are most likely due to long-continued conditions of hard weather, when other food is unobtainable, and to the presence of large numbers of immigrants which, having left central Europe in the belief that food was more plentiful across the North Sea, add to the problem of the rook food supply in the lands they visit.

There is another side to the activities of the rook, but the account of its benefactions and the final discussion of its place in agriculture I reserve until, having enumerated the bird pests of green and root crops, I have completed the black list of its crimes. It is sufficient to state here that if rooks are found to be damaging newly sown or ripe corn crops, no better preventative can be found than the old-fashioned crow-boy with his noisy wooden clappers. Mechanical scare-crows, which have been invented galore, lack the unexpectedness of the human element, and to all of these the wise and wary rook becomes accustomed in due course. Perhaps the most efficient deterrent, other than the boy, is the presence of dead rooks hung on tall stakes throughout the field.

LEAF ROLL, MOSAIC, AND RELATED DISEASES OF THE POTATO.

PART II.

Transmission. — With the exception of Aucuba mosaic, marginal variegation, and the different forms of streak, it has been demonstrated beyond doubt that the deterioration diseases under consideration are spread in the field by greenfly. In the case of leaf roll it has also been demonstrated that Capsid bugs and Jassid flies also transmit the disease freely in the field. The fact that insects carry the disease is of great importance, as it gives the key to the control of the disease.

The virus has no independent soil existence, and infection has not been shown to pass from one plant to another through the soil. It has also been shown in the case of leaf roll, mosaic and stipple streak that greenfly can spread the infection from the sprouts of diseased tubers to the sprouts of healthy tubers in storage.

In all deterioration diseases of the potato which are here dealt with, except marginal variegation, the infection can pass from one plant to another whenever organic union takes place, as in grafting.

The infection of mosaic and crinkle of the potato can also be transferred by expressing fresh juice from the leaves of diseased

plants and applying it to the bruised surfaces of healthy leaves. Certain mosaics of tobacco can be transferred by utilising dried infected leaf tissue macerated in water. There is no information to show if virus can be transmitted from ground keeper tubers or decayed roots to growing roots or stolons through the agency of soil animals such as greenfly or eelworm. So far as is known, no transmission takes place by actual contact of plants alone or by wind or other mechanical means.

Diagnosis of Disease.—It is frequently difficult to diagnose the type of disease or disorder which is affecting an unhealthy plant. The symptoms of each disease may differ on different varieties, and may sometimes resemble symptoms of purely functional disease. The correct diagnosis is accomplished by grafting an affected stalk on to a healthy plant whose different disease symptoms are known. If virus disease is present, the particular type of disease on the scion will be divulged by its appearance on the stock. The iodine test is effective in the diagnosis of leaf roll. The diagnosis is important because if virus disease is not present the disorder will not be perpetuated. Further, there is the possibility that different diseases may progress differently in different localities.

Mixtures of Diseases.—It frequently happens that the virus diseases occur in mixtures. To separate out the diseases it is only necessary to carry out a grafting test. The rate of diffusion of the virus from the affected scion to the foliage of the stock is different for each disease; consequently the symptoms of each disease present can be noted appearing in succession.

Essential Conditions for Experimenting.—Very frequently false conclusions are drawn respecting virus diseases because the observer has omitted the necessary precautions to prevent infection. Observations on the nature of virus diseases can only be made when virus carrying insects are totally excluded. This may be accomplished by the use of insect proof cages, by working in a greenhouse which can be easily fumigated, or by working in field conditions where there are no carriers, *e.g.* possibly on very high exposed hill ground.

Rate of Diffusion of the Virus.—The manifestation of the virus after the date of infection differs according to disease, variety and cultural and climatic conditions. The following results for the period of incubation (*i.e.* time between infection and appearance of symptoms on the leaves) were obtained in respect of the Green Mountain variety in the United States of America:—

Mosaic usually over 25 days.
Crinkle about 14 days.
Stipple Streak about 12 days.
Leaf Roll usually over 25 days.
Unmottled Curly Dwarf usually over 25 days.

The period which the virus takes to reach the tubers from the time of infection is of much greater importance. In the same variety it was found, as a result of subsequent planting, that the mosaic virus had reached some of the tubers 10 days after infection, and that the greater the number of days beyond 10, the

greater the number of tubers were infected. Forty days was sufficient in one experiment for all the tubers to be affected.

It has been found in controlled experiments in natural conditions in the field that crinkle is much more infectious than mosaic, and that mosaic is more infectious than leaf roll, degree of infection being taken to correspond with degree and extent of spread.

No information on the rate of diffusion of the virus to the leaves and tubers is available for British varieties under British conditions. Control of the diseases is considerably hampered for want of this knowledge.

Perpetuation.—A fundamental fact in connection with virus diseases is that they are in all cases perpetuated by the seed tubers. When disease of this kind gets into a plant all its stock is permanently and incurably affected, except in the case of very late infections which may not have reached the tubers. It has been proved by grafting experiments that mosaic may be carried in a masked condition in the growing plants; it may appear visibly in subsequent plantings of a stock in which its presence was unsuspected.

No other means of perpetuation is known, although it is possible that one or other of the virus diseases may be carried either obviously or masked by other solanaceous plants, or even by other totally unrelated plants. Schultz and Folsom state "many species have mosaic, and interspecific transmission from one taxonomic family to another is unusual in comparison with that within such families, and that the mosaic diseases of various hosts, even in the same family, are by no means similar in behaviour in regard to seed transmission, infectiousness, viability of the virus, and efficacy of different methods of inoculation." The diseases affecting the potato may possibly also be carried over winter in the bodies or eggs of greenfly.

Transmission through the true Seed.—It is probable that transmission of potato virus through the true seed obtained from the potato berry occurs only rarely. Instances of such transmission have been recorded, but in these cases the possibility of infection of the seedlings while growing was not excluded. Murphy, however, considers that leaf roll is very occasionally conveyed directly from the parent plant to the embryo in the seed, the resultant seedling being diseased from the beginning.

Transmission of mosaic through the true seed is common in beans and also occurs in clovers and cucumber. It is also doubtful in one form of tomato mosaic. Transmission of virus by the pollen has been recorded for Datura, a species of the same family as the potato. Accurate information is necessary for the information of the potato breeder regarding the advisability of neglecting diseased plants for breeding purposes.

Nature of the Virus.—The following facts regarding virus diseases in plants have been established. The virus can only continue its development in living cells. It appears to travel only through the phlœm, and does not seem to be equally active or equally concentrated in all parts of the plant.

A feature of most of these diseases is that primary infection is followed by the appearance of symptoms in the newly formed

Leaf of Irish potato, Green Mountain variety, infected with mosaic. Medium stage of disease. Note mottling and crinkling.

PRESIDENT.—(1) *Left*, Leaf roll; (2) *Centre*, Slight mosaic; (3) *Right*, Severe mosaic. These three plants were grown in equal conditions at East Craigs. The large tuber at (1) is the unexhausted sett.

o by Mr D. Cuthbertson, by courtesy of Messrs. Dobbie & Co., Ltd.

shoots and leaves only. Leaves that have already reached their full size remain visibly unchanged by such infection.

It would appear that plants carrying mosaic infection from the previous year develop the mottling and wrinkling in each leaf as it is growing, and not thereafter, but this is a statement which requires verification. Virus can exist in mature tissues and renders them highly infectious, but is apparently unable to affect any but developing tissues except where it causes starch accumulation in leaf roll of the potato.

Although the virus will pass through fine filters, there are standardised filters which retain it.

Investigations on one particular virus of the mosaic type in tobacco have indicated that virus may be destroyed at very high temperatures, and may be precipitated by certain chemical reagents; that it may retain its infective power for a short period as expressed unbottled juice and for longer periods as bottled juice, or in dried leaf tissue; that the infective juice can be highly diluted and still remain infective; and that virus can be cultivated in an appropriate medium, the subsequent product having a greater concentration of infection than the original infective sap.

There is a difference in the powers of resistance and longevity between the mosaic virus of one species of plant and another. It is possible that a similar difference exists between the virus of each of the different virus diseases which attack the potato.

The Insect Problem.—It has already been stated that the transmitting agents in the field and even in storage are certain sucking insects, chiefly Aphids (Greenfly). It has been proved that it is not the insects themselves that cause the damage, but the infective principle which they carry. Occasionally, however, they may directly produce dwarfing, mottling, chlorosis, wrinkling, streaking and complete necrosis, even when non-virulent, especially if abundant. They may also damage the sprouts.

Greenfly may be so influenced by certain conditions that they do not accept a new host readily. T. P. M'Intosh reported in 1921 the observation that greenfly seem to prefer some varieties of potatoes to others. The explanation given is that there are differences in the palatability of the sap of different varieties. Palatability of the sap may vary in different circumstances, and in some environments and at certain stages the sap may be agreeable to greenfly, while in other environments and at other stages it may be disagreeable.

The species of aphids which frequent the potato may not all be capable of transmitting virus disease, or may not be so at all times. In tobacco and sugar cane only certain of the species infecting the plants have been proved agents of dissemination of the respective mosaic diseases. Four species have so far been found on potato haulms and three of them have been found on potato sprouts. Other common species occur only as casuals.

A full account of these insects in relation to their occurrence on the potato has been given by F. V. Theobald in "The Aphids attacking the Potato."

The two most common aphids on potato plants are the green and pink aphis, *Macrosiphum solanifolli*, and the spinach aphis,

Myzus persicæ. The former is also found on roses and on many other plants. It winters in two ways, namely, as eggs on roses, and as eggs and apteræ (wingless females) on potato tubers and sprouts and probably on other plants.

The latter has a wide range of food plants which include practically every species with the exception of conifers and certain other trees. Under glass it will breed all the year. Normally it lays its eggs in autumn on peach, nectarines, daphne, brassicæ and also on potato tubers. The eggs may hatch as early as January. The sprouts of potatoes are sometimes destroyed by it. It is a cosmopolitan insect and is found nearly all the year round.

Greenfly occur on potato plants mainly on the undersides of the leaflets and on the flowering parts. They pierce into the food conducting tissues and extract the elaborated sap. They occur also on the sprouts.

A subterranean species has been reported to be present on the roots.

Aphids which have been feeding on the sprouts may come above grounds with the young shoots and so infest the foliage. Greenfly under favourable conditions increase at a prodigious rate.

Because of the numerous kinds of plants on which potato aphids feed, it is impossible to control them by killing out their alternative food plants.

The general opinion is that aphids are more plentiful in warm climates and in sheltered positions. It is in these conditions certainly that virus diseases spread most. Murphy has stated that low temperatures or excessively high temperatures retard the development and reproduction of aphids. Aphids appear on potato plants in the Lothians about the end of June, and are most common from the middle of July to the middle of August. They are much less frequent in September.

It is believed that in the North of Scotland the comparative freedom of potatoes from virus diseases and the comparative absence of the spread of these diseases is due entirely to the fact that greenfly do not thrive and multiply in that region. Similar observations in regard to other regions have been made by Schultz and Folsom, Murphy and Quanjer. Probably this is the chief explanation, although it is also possible that the conditions in the North are not so suitable for the development of the virus.

Two facts in connection with aphid transmission are of great importance:—

(1) In investigations on the nature of spinach blight it was found that aphids kept from feeding on infected plants transmitted the disease up to at least the fourth generation.

(2) In curly leaf of the beet the insect is not a mere mechanical carrier of the infection, but is an alternate host in which the virus undergoes some change.

No evidence is available to show that either of the above two phenomena occur in respect of virus diseases of the potato. It does not seem likely that the virus of any of the potato diseases requires to spend a period of its existence in an insect, because mosaic,

leaf roll, crinkle and stipple streak can be transmitted by grafting.

Accurate and extensive investigations are necessary to establish the distribution, frequency and multiplication of greenfly, their mode of hibernation, and the influence of host, locality, season and other environmental factors on their growth and feeding habits.

Conditions which affect Virus Diseases.—The development of the virus can only be gauged from its effects on its hosts. The progress of the various diseases may be influenced by factors affecting (1) the virus itself; (2) the insects concerned; (3) the growth of the potato plants. The variation in symptoms which occurs is most marked in mosaic. Murphy found that if part of a stock affected with mosaic was sent from the East of Canada to the West, the stock in the West lost its mosaic symptoms and suffered no reduction in yield. When the stock was returned to the East the mosaic symptoms reappeared, showing that the virus had not left the stock, but was merely masked. Murphy also has observed over several seasons that *a cold and dull early summer has the effect of increasing the amount of disease in the same season, but if the early summer is warm and sunny the development of mosaic is less.* This most important observation means that when conditions are adverse to the potato the mosaic virus flourishes, and conversely, when the potato plant is flourishing, the virus is partly checked.

Air temperature has been found to have a marked influence on the incubation period and symptoms of this class of disease, but apparently not always in the same direction. "In tobacco mosaic the optimum for the activity of the virus as judged by the length of the incubation period is 82° F. to 86° F. and the maximum near 97° F. The development of the symptoms is slowed down by lower temperatures proportionately to the growth of the plant, and no symptoms appear at temperatures that quite check growth."

Schultz and Folsom found that a reduction in sunlight may decrease the apparent dwarfing effect of a disease and increase mottling. Mottling alone, especially if not severe mottling, does not seem to be detrimental to yield, subject to the variability of the symptoms on different varieties. In some varieties mottling may only be an early stage, while in others mottling may be the final expression.

Recent observations by several observers in the United States of America showed that high temperature eliminated all forms of crinkling and reduced mottling, and that high temperature along with intense sunlight eliminated mottling. Low moisture also decreased the mosaic symptoms, but was not such a potent factor as high temperature or intense sunlight. It was further found that short periods of four to eight days of high temperature and increased sunlight were sufficient to eliminate the leaf symptoms of mild mosaic and to decrease those of the more severe types. It should be noted that the virus was considered to be still present in the plant, but the symptoms were suppressed.

The Ministry of Agriculture and Fisheries state in their leaflet that "the mottling appears to be materially modified by climatic conditions. In cooler and damper regions typical mottled foliage may be found throughout the entire season, but in the hotter and

drier parts of the country this feature, though quite apparent earlier in the season, may become much less marked later, and may even disappear; the crinkling of the foliage, however, remains. It would also appear from certain experiments that, though the typical mottling is more conspicuous in the north, the effect of the disease may be more serious in the hotter parts of the country." Murphy has repeatedly made similar statements, as have Schultz and Folsom. In Scotland, on the other hand, even if the mottling is very evident, the dwarfing and wrinkling are frequently absent. It is, indeed, frequently not until a stock reaches a warm climate that dwarfing and wrinkling appear.

It is likely that the disease which ravages England is not mild mosaic but crinkle or a severe grade of mosaic in which mottling is not necessarily a constant symptom. It may be different from the forms of disease known in certain parts of the United States, where conditions of temperature, sunlight and moisture are not analogous with those pertaining in the South of England. It has also to be taken into consideration that although the mottling may be absent in England the dwarfing and wrinkling of the foliage is very marked. Further, it is undoubtedly the case that leaf roll is responsible for many of the dwarf plants there.

It was found in Nebraska and elsewhere that the effect of the environment on the symptoms decreased with the increasing age of the plant.

Schultz and Folsom found that high-nitrogen and high-potash fertilisers decreased the percentage of mosaic and the distinctness of mottling in those mosaic. Preliminary experiments in Cheshire have indicated that artificial nitrogenous manures alone favoured the spread of greenfly on potatoes, while the addition of potash to the nitrogen decreased it.

In Scotland it has been noted that potatoes grown after wild white clover were in a very vigorous condition. although Mackelvie did not observe any reduction in the development of mosaic from planting after wild white clover in Arran.

A German experimenter has suggested that green manuring has a similar effect on potatoes to that of vitamines on man, and that, provided reasonably healthy plants are used to begin with, no additional mosaic develops if crops are well green manured. As green manuring would improve the water holding capacity of the soil, this agrees with Cotton's statement that vigorous plants, well supplied with water and in congenial soil, suffer less from aphis attacks than those less favourably situated.

With regard to all the virus diseases transmitted by insects, it has to be remembered that cold, moist, boisterous weather is unsuitable for greenfly, and that, therefore, although some symptoms develop rapidly in these conditions, the amount of spread of the infection is greatly reduced as long as these conditions prevail.

Poor growth conditions and poverty of land are considered under Scottish conditions to aggravate mosaic and leaf roll. This view meets with general approval among growers, and indicates the supreme importance of proper cultivation and manuring in the production of seed stocks. Hiltner (Munich) considered that the use of artificial fertilisers of too high-nitrogen content increased the

degree of mosaic in stock grown from plants so manured, but that manuring with dung without artificials exercised a beneficial effect both on the growing crop and the subsequent crop derived from it. In the light of present knowledge the position for Great Britain may be summed up as follows:—Having due regard to variety and origin of seed, a stock which is not more than very mildly affected with mosaic and is in a vigorous condition does not develop mosaic in any greater degree provided it is given good growth conditions, a warm early summer, and freedom from aphid infestation. If, on the other hand, a mildly infected stock is given unsuitable growth conditions or a cold early summer, the degree of mosaic increases, or if aphids are present the infection will spread over the stock and probably new infections will be introduced, rapid deterioration resulting.

Observations made on a small scale on early and late plantings at Edinburgh are interesting. Parts of the stocks of a few seedlings were planted in March. The subsequent plants developed mosaic in the beginning of July. Other parts of the same stocks were planted about the middle of June. No mosaic was visible on the later planted stocks.

Murphy also found that *late planting decreased the symptoms of mosaic*, and this observation has been confirmed in Nebraska.

The relative advantages, in the production of seed stocks, of early planting with early lifting and of late planting have not been tested in this country. The lateness of development of plants in the north may be a condition which favours the maintenance of health in north country stocks.

Deep planting would be advantageous in this respect, that if the drills were not much harrowed down the plants would be very late in brairding and might consequently miss adverse weather.

The effect of soil on virus diseases is limited to the effect which the soil has on the plants. It is known, however, that clay or peaty soil produce more vigorous stocks than sandy soils, other conditions being the same. Quanjer described symptoms resembling disease symptoms arising from the continued use of both acid and alkaline manures, from excessive soil moisture and excessive drought.

Vigour of Stocks.—It was formerly supposed that the vigour of a stock depended entirely on its comparative freedom from virus diseases, but there is now some evidence to show that vigour may be affected by environment independently of diseases, and that certain localities and soils produce more vigorous stocks than others. Exposed high lying or late districts are those from which the best seed stocks are derived.

Effect of Storage.—Various statements have been made that conditions of storage influence the appearance of mosaic and leaf roll and affect the vigour.

Heating of the tubers undoubtedly reduces the capacity for sustaining the growth of sprouts and young plants. In German literature it has even been stated actually to cause the appearance of mosaic. Quanjer does not consider that heating of the seed can cause leaf roll. Small scale experiments at East Craigs have

indicated that heating of seed tubers from slightly affected plants may cause an increase in the amount of mosaic and marginal leaf rolling mosaic in plants derived from these tubers.

Attempts have been made to kill the virus in the tuber by heat, but it was found that, under the conditions of the experiments carried out, the tuber was killed before the virus. Possibly a different result might have been attained had the conditions of the experiment been different. Unpublished experiments by Kendall have shown that tubers can be maintained at a temperature of 140° F. in a moist atmosphere for two hours without being killed. Potatoes in pits frequently become heated through mismanagement. Potatoes should be pitted dry and should have sufficient ventilation, especially when newly pitted.

The chilling of potatoes has been considered by growers to result in weakened stocks. In Germany it has been stated that a moderate amount of chilling may entirely eliminate the virus from the tubers. No confirmation of that view has been obtained. Slight chilling has the effect of delaying sprouting and early growth. Mosaic or leaf roll symptoms consequently appear later in the season. This appearance, however, is only delayed; it is not eliminated. Also late sprouting is partly equivalent to late planting. Potatoes freeze when they attain a temperature of between 26° F. and 28° F. The freezing point varies with the conditions of the tubers and with the conditions of the experiment. A temperature of between 38° F. and 42° F. is recommended for storage.

Complete freezing, of course, kills the tubers, but partial freezing may be very injurious in the following way. The food material is more concentrated about the eyes of the tuber than it is in the interior. Consequently the tissues about the eyes, including the sprouts, are more resistant to freezing than the interior. It frequently happens that the internal tissues are killed, but the eye tissues and the sprouts remain unaffected. Sprouts develop but die off quickly after planting, generally without producing above-ground parts, because the cells of the interior have broken down and the young shoots are starved. Blanking in a field is often due to that cause. The tubers appear quite normal at planting time and give no obvious hint that the interior is frozen. Instead of dying off the sprouts may obtain sufficient food to produce small plants. In instances where this has been known to happen the plants did not make satisfactory growth and appeared weak throughout the whole season. Such plants had certain similarities in appearance to plants affected with mosaic, and possibly in these instances the effect of chilling was to intensify the symptoms of mosaic already present.

Effect on Yield.—The injurious effect on yield of virus diseases varies from *nil* to almost total destruction. Sugar cane mosaic in Louisiana is stated to produce such slight effects even when all plants are affected that no reduction in yield of sugar takes place. Individual stocks of potatoes becoming infected with an apparent complex of virus diseases at East Craigs have been totally destroyed by disease within four seasons from the original healthy parent plant. It may be as well to summarize the position in

respect of leaf roll, crinkle, marginal leaf rolling mosaic, and the different grades of mosaic.

The loss from leaf roll in its secondary form may consistently be very well estimated from the appearance of the crop in the field. A loss of from 25 per cent. to 50 per cent. in the gross yield of each plant affected is usual. In addition the crop consists of undersized tubers, so that the loss of ware sized tubers is even greater.

The loss in respect of crinkle may also be consistently gauged. In this case the loss may be much greater than that due to leaf roll, and is always serious. Marginal leaf rolling mosaic also consistently affects the yield, and in a broad sense the loss may be said to be approximately equal to that from leaf roll.

The reason that the loss may be fairly accurately estimated in respect of these three diseases is that the symptoms do not vary greatly and the severe stage is reached in the second year of infection.

With mosaic the problem is different. It would be very difficult in many cases to estimate the loss in yield due to mosaic merely by looking at the haulms. The reason for this is that mosaic may assume many different grades. The following general statement may be made. Reduction of the total leaf area of a plant, accompanied by general dwarfing and by a marked dullness in colour or unevenness of the leaf surface, may bring about a depression in yield to the extent of anything between 25 per cent. and 75 per cent. Severely affected plants yield no large tubers. The effect on yield depends on the intensity of the symptoms, which varies with different varieties. When mosaic fails to produce any of the above symptoms and is evident merely as a mottling of the leaf, the yield is not appreciably affected. As a matter of fact it would be safe to say that a very large percentage of potato plants in the chief ware potato growing districts in Scotland have the mottled appearance, though the percentage with severe mosaic is small. The important statement made by Murphy and others that when the mosaic symptoms are suppressed or masked there is no reduction in yield, may be repeated here.

Plants affected with leaf roll, mosaic, crinkle and marginal leaf rolling mosaic are influenced by cultural conditions in the same direction as normal plants. Thus high manuring enables affected plants to produce fairly good yields, while poverty causes such affected plants to be very miserable specimens indeed.

Control.—The factors to be kept in view are that all the diseases mentioned are perpetuated by the tubers, and that in the field mosaic, crinkle and leaf roll are spread by greenfly.

In the case of diseases transmitted only by organic contact, such as Aucuba mosaic, rogueing should be very effective. The importance of this class is, however, negligible. With regard to stipple streak and other forms of streak there is no anxiety, as they are only of casual occurrence. Leaf roll, crinkle, mosaic and marginal leaf rolling mosaic constitute the problem.

No tubers from plants affected with leaf roll, crinkle, marginal leaf roll and the severe forms of mosaic should ever be used for seed. Advice in respect of mosaic is incomplete *until we know the corre-*

lation, if any, between mild or medium mild mottlings and the severe forms of mosaic, and until we know if a plant or a stock affected with mild mosaic is any more likely to develop severe mosaic or to contract other virus diseases in England than a plant or stock of normal appearance. The profitable use of a stock of mildly mottled plants probably depends on where the stock was grown and where it is intended that it should be planted, and varies with the variety as well as with conditions previously noted.

Rogueing.—The usefulness of rogueing depends chiefly on the nature of the disease, on the presence or absence of greenfly, and on the locality and climate. With a knowledge of these, rogueing becomes a matter of common sense, in which it is impossible to lay down regulations.

When greenfly and other carriers are not present in abundance, rogueing should be effective for leaf roll and crinkle and the severe forms of mosaic, but its profitableness would depend on the percentage of plants which had to be removed. Certain varieties are so extensively affected with apparently mild mosaic which is not perceptibly lowering the yield of the stocks, that rogueing would mean the elimination of most of the plants.

Insect carriers are, however, not of common occurrence. When they are present, the efficiency of rogueing will depend on the number of plants affected and the number of greenfly present. In the chief potato growing districts in the Lowlands of Scotland, rogueing is not likely to be profitable unless the percentage of affected plants is very small. *The introduction of stocks from a late and exposed district is a more profitable expedient. This is, in point of fact, the established remedy of the practical grower, and present scientific knowledge cannot improve upon it.* Rogueing is a practice which is much more valuable in late and exposed districts than in the Lowlands. Rogueing of mild mosaic is not recommended in all cases, even in seed districts, owing to the lack of knowledge regarding the difference between mildly mosaiced plants and normal plants. If it is desired to rogue out plants with mild mottlings, rogueing should commence as soon as the plants are well through the ground, and should continue all season.

In order that sources of infection may be removed, rogueing out of diseased plants should commence before the first aphid infestation, and should continue throughout the season in order to ensure the removal of plants which develop symptoms later.

A good seed stock should contain no plants affected with leaf roll, crinkle, severe mosaic and, depending on conditions, mild mosaic. The view is here expressed that much could be done to improve stocks in seed producing areas, although it cannot be said that the number of bad stocks in seed growing areas is large. The contrary is the case, but a general levelling up is possible.

Stock Seed.—The best method of improving potato stocks and maintaining them in the best possible condition of health is the selection of individual healthy plants, and the growing of the produce for stock in an isolated plot. Requisites for the success of this method are that the original stock is reasonably healthy and grown in a reputedly good seed district, where greenfly are not prevalent. The Board of Agriculture for Scotland have a working

scheme for the recommendation of healthy crops in seed districts for use as stock seed.

Immature Seed.—It is often supposed that immature seed prevents or reduces the amount of disease. The use of immature seed cannot prevent the disease, but it is often efficacious in reducing the amount of disease in a stock if the infection is recent. Early lifting of tubers is always advisable in a relatively healthy stock, as it means that the tubers are secured before the infection spread by greenfly has had time to penetrate to them. Stocks lifted before the end of July are likely to escape most of the new infection for that season. Immaturity in itself is not of any value in seed tubers, but immature tubers sprout quicker than ripe tubers. The early lifted tubers from badly infected plants produce no better stock than the ripe tubers. Mature tubers have often been condemned for seed, but mature tubers are inferior to immature tubers only in the case of recently or lightly infected plants, when the infection has had a longer opportunity of diffusing into the growing points of all the tubers. In the raising of new varieties, the available evidence shows that some tubers at any rate of the stock of each seedling should be lifted as early in the season as they are in a condition for keeping in order to provide a nucleus of healthy stock.

Cutting of the Haulms, which is sometimes carried out as a preventive against blight, is perhaps a better plan than early lifting of tubers, and has this advantage, that the tubers keep well even when cutting is carried out as early as the middle of July in the case of first early varieties in the south of Scotland.

Spraying.—Under field conditions an insecticide spray fails to reach all the greenfly, as they feed mostly on the undersides of the leaves on strong growing plants, and, consequently, even repeated and careful applications leave sufficient greenfly to multiply and to spread infection.

In the case of seedlings it is advisable to spray frequently, because with the very small number of plants involved care can be taken to soak thoroughly all parts of the plant. Small plants should be completely immersed in the spray solution. It has been found possible in a town garden to keep over two hundred plants free from greenfly by spraying weekly during July and August.

The best spray to use is Nicotine Sulphate, either alone or with black soap. Nicotine Sulphate may be had in handy form as "Black Leaf 40," a commercial brand. A suitable fumigant for use in greenhouses and storage houses is Tetrachlorethane, which can be obtained in a commercial form as "Westrol."

Spraying and fumigating in the above manner should always be resorted to in plant breeding establishments when greenfly are present.

Breeding for Immunity.—The view is now fairly widely held that the only way of combating virus diseases is to breed varieties which are either immune or else very resistant. Blight is held in check by resistant varieties and wart disease is avoided by the use of immune varieties. *With regard to virus diseases the problem is more difficult because there is more than one disease, and resistance to*

one does not postulate resistance to the others. No variety is known which is immune from even one of the common virus diseases when grown in the ware-producing districts. Some varieties are, however, very resistant to one or more under Scottish conditions. There is little doubt that the success which popular varieties have had on the market has been due to their resistance to virus diseases, particularly severe mosaic. Such varieties are Up-to Date, British Queen, Epicure, King Edward VII. and Great Scot. Arran Chief is an example of a popular variety which is losing favour on account of the stocks becoming infested with a virus disease.

Potato breeding received a great impetus from the Wart Disease Orders, but no acceptable variety produced since then has been able to overcome the virus menace. Nevertheless a number of seedlings has come under observation at Philipstoun which appear to be little affected by virus diseases. *It is from such types and from standard varieties which are resistant that further breeding should be done.* In addition to the unnamed seedlings, suitable varieties resistant to one or more of the diseases are as follows:—Epicure, Sharpe's Express, Ally, Great Scot, King George, British Queen, King Edward VII., Flourball, Sutton's Abundance, Up-to-Date, Field Marshal and Shamrock. When breeders concentrate on producing resistant varieties the probability is that varieties acceptable to growers will be forthcoming.

Virus Diseases and Potato Breeding.—In a breeding establishment it is necessary to have many plants for use in breeding and comparison as well as numerous seedlings of different ages. Such establishments are generally in proximity to commercial potato fields. The probability, amounting to a certainty, is that virus diseases are present in or near the establishment. Spraying is advisable only on a very small scale; on a larger scale it is impossible to prevent greenfly from reaching the seedlings. Thus many good seedlings get so much infection that they cannot resist it, and the whole stock of each seedling is irreparably infected. Even a resistant seedling has little chance of escaping infection in such conditions. The remedy suggested is that a small station be established in the hills two or three miles away from the nearest potatoes. The only potatoes that ought to be grown at such a station would be seedlings in the first and subsequent years of their existence. If deemed worthy of trial small parts of the stocks should be sent to the lowlands to test their reaction to virus diseases. In this way stocks would be sent out to growers free from virus diseases. This station could also be used to establish whether or not virus diseases are transmitted through the true seed.

Conclusion.—Notwithstanding the great amount of work that has been done on virus diseases of the potato, the real nature of the virus is still unknown. Even with regard to field observations, information is very conflicting; especially is this obvious when mosaic is considered. Sufficient knowledge is not available to account for all the field observations that have been reported in this country. The mosaic situation is complicated, and the complication is made more difficult by the apparent complexes or combinations of diseases which may be occurring. Practical con-

trol has not appreciably advanced since the days of our forefathers —two hundred years ago—who found it expedient to obtain their seed stocks from the hills. The disorders are clearly associated with nutrition, and profound alterations must occur in the enzymic activities of diseased plants. It is evident that an immense advance in knowledge is still required before the effects on the metabolism of the host can be clearly understood and perfect control measures elaborated. To this end, co-ordination of the work of research workers in this country is necessary.

BIBLIOGRAPHY.

Atanasoff, D.—"Stipple-Streak of the Potato." Wageningen, 1922.

Atanasoff, D.—"A Study into the Literature on Stipple-Streak and Related Diseases of Potato." Wageningen, 1922.

Butler, E. J.—"Some Characteristics of the Virus Diseases of Plants." *Science Progress*, No. 67, Jan. 1923.

Cotton, A. D. — "The Situation with regard to Leaf-Curl and Mosaic in Britain." International Potato Conference, London, 1921.

Folsom, D.—"Advances in the Study of the Virus Diseases of Irish Potatoes in 1923." Annual Proceedings of the Potato Association of America, Dec. 1923.

Folsom, D.—"The Importance and Natural Spread of Potato Degeneration Diseases." Bull. 316, Maine Agric. Expt. Station, Jan. 1924.

Goss, R. W.—"Effect of Environment on Potato Degeneration Diseases." Research Bull. 26, University of Nebraska Agric. Expt. Station, March 1924.

Lawson, C.—*Agriculturists' Manual.* Edinburgh, 1838.

Ministry of Agriculture and Fisheries.—Collected Leaflets on the Cultivation and Diseases of Potatoes. London, 1921.

Murphy, P. A.—"Investigation of Potato Diseases." Bull. 44, Canadian Department of Agriculture, Ottawa, 1921.

Murphy, P. A.—"Leaf-Roll and Mosaic Diseases of the Potato." Jour. of Depart. of Agric. and Tech. Instruction for Ireland, Nov. 1922, Jan. 1923, Feb. 1924.

Murphy, P. A.—"New Work on Mosaic in Ireland." International Potato Conference, London, 1921.

Pettybridge, G. H.—"Diseases of the Potato." Scottish Potato Conference, Edinburgh, 1924.

Quanjer, H. M.—"Nature, Mode of Dissemination and Control of Phlœm-necrosis (Leaf-roll) and Related Diseases." Wageningen, 1916.

Quanjer, H. M.—"New Work on Leaf-Curl and Allied Diseases in Holland." International Potato Conference, London, 1921.

Quanjer, H. M.—"General Remarks on Potato Diseases of the Curl Type." Report of the International Conference of Phytopathology and Economic Entomology, Wageningen, 1923.

Schultz, E. S., and Folsom, D.—"Transmission, Variation and Control of certain Degeneration Diseases of Irish Potatoes." *Jour. Agric. Research*, July 1923.

Stuart, Wm.—"The Potato." New York, 1923.

Theobald, H. V.—"The Aphides which attack the Potato." South-Eastern College, Wye, 1923.

West, Cyril.—"Plant Physiology—Effects of Cold Temperatures." *Science Progress*, vol. xviii., No. 71, Jan. 1924.

"Nature." Feb. 28, 1925, pp. 315-316.

A FURTHER CONTRIBUTION TO THE SUBJECT OF SCRAPIE.[1]

J. P. M'GOWAN, M.A., M.D., B.Sc.,

From the Rowett Research Institute, Aberdeen.

IN previous papers (1, 2, 3), evidence has been adduced to show that a heavy infestation of the muscles with sarcosporidia (*Sarcocystis Tenella*), of ordinary or increased virulence, is the cause of scrapie. The sarcocyst, in all probability, occurs in varying degrees of infestation in every sheep. When this infestation becomes heavy, symptoms of its existence develop and these are the symptoms of scrapie. The itchiness is caused by a toxin or poison, the sarcocystin present in the sarcocyst. The weakness of the muscles is due to the parasite damaging the contractile fibres of the muscle.

Experiments were carried out by the writer which showed that the sarcocyst was transmissible from the mother to the lamb through the uterine wall. Scrapie was shown to be transferable in the same way. Other experiments showed that scrapie, and consequently the sarcocyst, was transmissible through the milk of diseased animals. Apart from this, field evidence shows that the method of transmission of scrapie in nature is from the mother to the lamb.

A ewe, suffering from scrapie and therefore heavily infested with sarcosporidia, will pass on a heavy infection of the parasite to her lamb. In a lamb, therefore, say from an old ewe suffering from the disease, the disease will appear much earlier than it did in the mother, usually at or about two years of age. This is owing to the heavier infestation at the commencement of life in the one case as compared with the other.

Scrapie has made its appearance at different times in different countries. The onset of the disease has usually been on high-grade and pedigreed sheep. The outbreaks have usually been associated with attempts to grade up the breeds. This point is significant.

Scrapie is usually limited in its distribution to a certain area of country. This takes place in spite of extensive transference of sheep, which has been going on for years, from the diseased area to other parts. That it does not spread in these parts is due to the non-infectiousness of the disease. It is also due to the different type of breeding employed in these other parts.

There are two types of the disease epidemiologically. First, there are the chronic, sporadic, spontaneous cases, appearing among the old ewes. These arise *de novo*, and are not the consequence of infection from a previous case of the disease. Secondly, there are the acute cases, running their course in two years or so. These are derived from the first type by congenital infection. Owing to the rapid evolution of the disease in this type and its "hereditary" nature, large numbers of cases occur in a flock in a short period of time, when the method of breeding is favourable to

[1] I wish to express my indebtedness to the Carnegie Trust, who have provided a grant towards the expenses of this investigation.

occurrence of the disease. This gives the outbreak the superficial appearance of an acute, infectious disease. It is not really so, however.

Scrapie is not transmissible from diseased to healthy sheep by ordinary cohabitation, even of the most intimate character. It is not, therefore, contagious.

There is a strong and fairly widespread belief that the ram is an active agent in spreading the disease both to the ewes with which he has connection and to the resultant progeny. This belief is, in all probability, devoid of foundation.

When the disease arises spontaneously in a flock it is sporadic in type and occurs first among the old ewes. This relates, of course, to cases where the disease is not introduced by infected ewes brought in from other flocks.

In the areas where the disease is endemic the ewe stock of the flock is usually kept up from the progeny of the gimmers. They are thus derived from the age most prone to this "hereditary" disease. Elsewhere the ewe stock is kept up from the best ewe lambs from all the ages of the ewes. A gimmer's lamb, therefore, being usually a poor lamb, is rarely chosen. Should it be chosen, and should it develop scrapie at two years of age, its lamb, being poorly nursed, will stand no chance of being kept for stock. In this instance the sporadic cases of scrapie, which do occur, are thus automatically eliminated from the flock, and so are prevented from doing further damage. In the other case they are artificially fostered.

Basing on these considerations I have elsewhere suggested a method for dealing with the disease. This is to cease keeping up the ewe stock from the progeny of the gimmers, and to obtain new members entirely from the older ewes. From what has been said, the rationale of this is obvious. Where this method has been used it has met with complete success even in already diseased flocks. Originally it was intended simply to protect already healthy flocks from the disease.

The conception of the disease just given was arrived at by a consideration of the "Field evidence," and the results of the two experiments mentioned. Many of the points are sufficiently vouched for on this evidence alone. Some, however, would be the better for further support. Especially is this the case in connection with the question of the relation of the ram to the spread of the disease. This is so because of the practical importance of this question. Additional evidence on this point can not be attained by experimental methods. It will serve no purpose to discuss why. One had therefore to be on the lookout for more accurate evidence to be obtained, if possible, in other ways. One was fortunate to meet with such an opportunity in having the whole records of a pedigreed flock in which the disease recently occurred made available for purposes of investigation. For obvious reasons the flock owner, who has conferred this benefit, wishes to remain anonymous. This opportunity, however, is taken of acknowledging obligation to him.

We will now deal with the occurrences in this pedigreed flock. It has been in existence for 25 to 26 years. It consists of Border

Leicesters. The flock was originally established by collecting together, for the first two years, ewes from various outside flocks. Since that time there has been no further introduction of ewes into the flock from outside. Rams, however, have been introduced at different periods.

Each year lambs are selected from the lamb crop of the year to keep up the ewe stock. Surplus ewe and ram lambs are sold to other breeders. The method of selection was based on the choice of animals which, according to the flockmaster, possessed the best breed points. In following this method of selection, vigour of constitution is apt to fall into second place. Indeed instances were noted where animals, lacking in robustness, were deliberately kept in the flock because of their being superlatively endowed with breed qualities. The occurrences, therefore, inside the flock, as regards scrapie, may be taken as representative of the whole stock bred in the flock, *i.e.*, both the sheep retained and the sheep sold. No trouble, with regard to scrapie, was noted inside the flock or was reported from outside until three years ago. At this time the disease was recognised in both situations. These two independent observations serve as a check on each other. They go to demonstrate the fact that scrapie first existed in the flock at or about the year 1922. This is a point of some importance, as first cases of scrapie are apt to be missed by the uninitiated.

By means of the flock book, the genealogy of every sheep in a pedigree flock can be traced back to the sheep which constituted the flock originally. All the cases of scrapie that have occurred inside the flock during the last three years, that is since the disease first made its appearance, have been so traced back. The result has been that, of a total of 63 scrapie cases, all have been traced to seven ewes back in the early days of the flock. There were thus seven "potential" scrapie strains in the flock. The word *potential* is used because not all the sheep of these strains developed the disease; all the scrapie sheep, however, occurred in these strains. The disease "potential" therefore was greater in them than in the other ewe strains.

The divergence of these strains took place as follows. In the first year of the flock's existence four potential scrapie strains arose; in the second year two strains, and in the fifth year one strain. The following are the number of scrapie sheep derived from each strain:—19 from strain 1, 9 from strain 2, 9 from strain 3, 8 from strain 4, 4 from strain 5, 11 from strain 6 and 3 from strain 7. The scrapie cases were rigidly confined to the seven strains. No cases occurred in any of the others. This is remarkable, considering that these seven strains have cohabited with the other strains all the time and considering also the fact that all sorts of rams, both scrapie[1] and healthy, have been used on both groups in common. If the disease were an infectious

[1] A ram actively suffering from the disease is impotent. Statements made, therefore, with regard to scrapie rams disseminating the disease can refer only to a ram which, apparently healthy at the time when he was in a position by his specific activities to disseminate it, developed scrapie at a later date. This is the sense in which the term is applied here.

one, or if the rams acted in any way in disseminating it, it goes without saying that the small number of seven strains could not have been separated out. Every strain in all probability would have produced specimens of the disease. The condition would not have been that of a few strains producing each a large number of examples of the disease, but a large number of strains producing each a few samples.

The occurrences here, therefore, support the "tentative" conclusions already drawn from the field evidence. The disease is not a contagious one. The ram can in no sense of the word disseminate the disease or originate it of himself. No alternative remains but to consider whether the facts connected with the ewe suffice to explain the phenomena of the disease. They are found to be amply capable of doing so. In this connection not the least of such facts are that of the occurrence of the scrapie strains just mentioned.

The relation of the ram to the disease may be elaborated from further information derived from this flock. In the period 1917 to 1919 three rams which ultimately died of scrapie were used in the flock. Death from the disease took place from 3 to 8 months after they had been used. Some of them had been used for two or more seasons in the flock and with the same ewes in different seasons. In all, during this period, they were applied to 300 ewes. In spite of this none of these ewes, although many of them were kept to extreme old age, developed scrapie. This circumstance disposes again of the popular idea that the ram transmits the disease to the ewe in copulation. Again none of the progeny of these rams with the ewes in question developed scrapie *except those from ewes of the seven strains above mentioned.* In the production of the disease cases, therefore, the ewes were all important. By no theory of chance could the cases have been limited to the seven strains, if the ram had acted as an infectious factor. The case is even stronger. One can conclude that the ewe has everything, the ram nothing to do with the origination of the disease.

It might be, however, that the ram could act as an accelerator or intensifier of a condition already pre-existent in a mild form in the ewe. If such an influence existed it could be explained by the supposition that the diseased ram combined his constitution, already predisposed to attack by the sarcocyst, with that of the predisposed constitution of the ewe in their joint product, the lamb. The result would be a higher predisposition to the disease in the lamb. The occurrences in the flock were examined from this point of view. No facts, however, were elicited which could be construed as favouring the possession by the ram of such an influence. So that the ram would appear not to be able even indirectly to affect the onset of the disease.

In previous communications the existence of *de novo* cases of the disease was insisted on. These are cases which can be supposed to originate without any relation to a previously existent case of the disease. The fact of their real existence is demonstrated in this outbreak. The first cases which occurred in this flock arose in several old ewes. These had been born into the

flock before any animal with scrapie taint had been introduced into it. This was at a time when the flock had already been 12 years in existence. They must therefore have arisen spontaneously or *de novo.*

The flock consisted originally of 60 to 70 ewes. There were therefore at the start of the flock 60 to 70 ewe strains. By selective retention of certain strains the number of strains present in the flock in the later years of the flock's existence was less, and the relative population in each strain different from what it was in the commencement of the flock. Certain strains being nearer the breeders' ideal had been intensively bred from. This means that lambs had been reared from individuals of favourite types of ewes as long as this was possible. This breeding from the very old ewes is the means by which the spontaneous cases arise in these pedigreed flocks. This can be expressed in terms of the sarcocyst origin of the disease. The longer a ewe lives, the greater will be the multiplication of the sarcocysts with which she starts life. A heavier infestation is thus produced. At the same time when the ewe becomes very old her vigour and vitality are lowered. Her body can, therefore, offer less and less resistance to the encroaches of the parasite. The result is that in the last few years of life there is a disproportionately greater multiplication of the parasite. The animal, therefore, becomes a case of scrapie. She may, however, not be, and often is not recognised as such. Itchiness is the cardinal symptom by which the disease is diagnosed. Owing to her apathetic disposition she may not display this symptom and so be missed. She is, however, a "trotting" case, the variety which occurs chiefly among the old ewes. She is thus a case of the disease which has arisen spontaneously. She passes on a very heavy infection to her lamb, with the result that the disease appears in it in a much shorter period—two years. This forms the starting-off point for the acute epidemic form. The spontaneous sporadic type and the acute quasi-epidemic type are thus explained in terms of the sarcocyst theory. The artificialities of present-day breeding modes convert the one into the other.

A ready explanation is also afforded by these considerations for the well recognised fact that the disease is specially prevalent in pedigreed flocks. While in commercial flocks stress must be laid on the keeping up the ewe stock from the two year old ewes, as the predominant cause of its prevalence there, in pedigreed stocks, the breeding from the very old ewes must be assigned the prominent rôle. But the other factor plays a part here also. For once a good type of lamb is obtained by the breeder there is a tendency to breed from this type as early as possible and to keep all the produce. In this flock the outbreak of the disease coincided with disproportionately large entries of gimmers into the flock.

It might seem that the facts related regarding the occurrence of the disease in very old ewes are at variance with recommendations made elsewhere for dealing with the disease. This is not so. For consider the case where, as will inevitably happen from time to time, a sporadic or spontaneous case arises either in an old ewe herself or her progeny. The old ewe will die and so be eliminated from the flock. The lamb will almost inevitably take

the disease at about two years of age, will die also, and so be prevented from doing further mischief.

Inbreeding has been alleged as a cause of scrapie. In this flock a fair amount of inbreeding took place. It was found to be impossible, however, to assess the influence of inbreeding here on the course of the disease. This was partly because it is of the nature of an acute attack to be progressive, and partly because during the years when inbreeding was practised a disproportionately large number of young sheep—thus actively predisposed otherwise—were being added to the flock. It should not, however, be forgotten that in pedigreed flocks where inbreeding is chiefly practised, other practices favourable to the development of scrapie exist. These have already been treated in the general discussion. It is not suggested that inbreeding may not have some influence, regard being had to the possibility of its power of producing a constitutional weakness. At most, however, its influence must be an indirect one. The opportunity will be available to assess it at its real value when the other more obvious and more important causes of the disease have been removed.

It will be seen that the "tentative" conclusions arrived at previously from an examination of the "Field evidence" have been confirmed and strengthened and in some cases have been amplified as the result of this investigation. It will not be necessary to recapitulate them except in so far as they are implied in a statement of recommendations for dealing with the disease. It will be seen that these recommendations are on the same lines as those given in previous articles. As a result of the new information additional point has, however, been given to some of them.

The practice of keeping up the ewe stock from the progeny of the gimmers should be done away with. The ewe stock should be kept up from the produce of the old ewes. Owing to the inevitableness of the occurrence of spontaneous or *de novo* cases in the old ewes, a case of scrapie now and then must be expected. If, however, the practice recommended is persisted in, the acute type of disease will be caught at its inception and prevented. The object should be to prevent the sporadic spontaneous chronic type of the disease from evolving into the acute epidemic-like form.

Breeding from very old ewes, which occurs especially in pedigreed flocks, should be avoided as far as possible, or at least the dangers attendant thereon should be realised and provided for.

In selecting animals for stock, robustness of constitution and family history as regards health should be taken into consideration. The reasons for this are obvious where there is a family history of scrapie. Every case, however, of lack of robustness should be regarded with suspicion, because in fighting a disease like scrapie the most stringent measures should be taken to eliminate any source of weakness.

The risk of suckling healthy lambs on scrapie ewes has been shewn to be a real one and should be borne in mind.

References.

1. M'Gowan.—Bull. Edin. and East of Scotland Coll. of Agriculture, 1914.
2. M'Gowan.—Scott. Journ. Agric., vol. iv., 1922, p. 365.
3. M'Gowan.—Parasitology, vol. xv., 1923.

Some Notes on Field Experiments.

THE following notes are by a contributor with a wide practical knowledge of field experimental work, derived from his own extensive experience and from a diligent study of the results of such experiments carried out by the agricultural colleges in both Scotland and England over a considerable period. The writer holds the view that many of these operations are of little value, and that the publication of the results of much of the work is very misleading. In this article he reviews the subject in a general way with the object particularly of pointing out its limitations and of suggesting what might lead to improvement in methods and results.

The first great difficulty to be met with in field experimental work is the getting of an area of land sufficiently large and at the same time sufficiently even in character so that the differences in the soil from place to place may not unduly prejudice the results. Anyone who has not carried out field experimental work has no idea of the extraordinary differences that are found in the character of the soil in the same field from place to place, and it is the writer's experience that it is impossible to pick out an even piece of land suitable for experimental purposes from a mere cursory surface examination of the field before, or even after, it has been ploughed. The experimenter should very carefully examine for two or three years at least the crops on any part of a field that he intends to use for experimental purposes before he can possibly pick out with any degree of certainty an area suitable for any reliable experimental work.

As an example of how far one can be misled by general appearances, the writer gives below the results of an experiment carried out on one of his own holdings some few years ago, his main object being merely to test the quality of a certain piece of land on which he afterwards wished to carry out experiments for himself. His primary object was to carry out manurial tests, and he selected from a field an area of 2 acres in extent, which was quite level and appeared to be very even in character. In the first year potatoes were grown here, the same variety being used and the soil being tilled and manured in exactly the same way over the whole area. At harvest time the 2 acres were then divided up into one-tenth acre plots, and the crop from each of these was weighed separately. The weights from the different plots varied from 8 tons to 12 tons per acre. It is quite evident that if single plot tests were carried out on this area with potatoes, the difference between any two plots owing to the uneven character of the land would be much greater than could be confidently expected from two different systems of manuring where the conditions were as nearly as possible the same. Even in this case had the plots been duplicated and the averages taken, many different results would have been got by a re-arrangement of the plots. In the following year the same area was put under oats, and again the same variety was used and the tillage and treatment was the same over the whole area. The crop was again harvested in one-tenth acre plots, and here the difference between the largest and smallest yields was nearly 30 bushels per acre. Again, a close examination

of the figures from the different plots made it quite evident that, whether they had been triplicated, or duplicated, or taken singly, the difference would have been greater than could possibly be expected from any two different systems of manuring.

Of course the larger the plots made use of, the less is the liability to error, while average results from a number of plots instead of from one may certainly give useful information; nevertheless, it must be clear that, unless the experimenter is very familar with the soil on which he is working, he may be very far misled in interpreting his results.

Before setting off any experiment in any particular field, therefore, he should study the crops on the area selected for two or three years previously. He will then be in a position so to arrange and so duplicate and triplicate his plots as to reduce the interference of any peculiarities in the soil to a minimum, and by so doing strengthen the value of the conclusions he draws from his work.

If, as these figures show, the character of the soil varies so much from place to place in one field, how much more is it likely to vary from farm to farm and from district to district? In much of the experimental work that is carried on at the present time, one set of trials is carried out one season on one farm and next season on another farm. The second trial is usually referred to as a repetition of the first, and is said to be carried out for the purpose of clearing up something unsatisfactory in that trial. Now, in the writer's opinion, they are two totally different trials altogether, and it is very misleading to say that the results of the one can confirm or deny the results of the other. Further, taking averages from different centres and arguing from these must be of very questionable value, unless or until the conditions at all centres are fully known and their effect on the results of the experiment clearly understood. If such work, therefore, is to be of any value at all in leading to really definite and conclusive results, it must be carried on on the same farm for a few seasons. Variations in the seasons themselves will influence so greatly the results that even on the same soil it is altogether unsafe to draw definite conclusions from any single season's results.

The writer, too, is strongly of the opinion that it is a very great mistake to publish the results of experimental work until some really definite and reliable conclusions have been come to. Many farmers still do not realise the limitations of such work, and are only too apt to follow the results blindly and apply, say, mixtures of manures which have given the best results in any single set of trials, without considering whether the conditions under which they were carried out are similar to their own or not. Premature publication of results of experimental work, therefore, must often lead to considerable disappointment to many farmers.

Exception might also often be taken to the way in which results are interpreted, and particularly the way in which they are put before the ordinary layman. For example, in dealing with manurial experiments the statement is often met with that "this experiment was carried out for the purpose of finding what this soil requires." But the main factor to be considered is not the soil, but the particular crop dealt with. The soil may, and does,

influence the action of manures differently, but each plant has its own particular requirements, and the results of a manurial trial must always be interpreted in terms of the needs of the particular crop dealt with, and not the soil. The manures required by an oat crop will differ very much from that required by a turnip crop on the same soil.

The writer recently had ample proof of the great necessity for care being exercised in this direction from an experience of one of his neighbours. In discussing manurial questions generally with this neighbour, the writer found that in one season an experiment had been carried out on this man's farm on the manuring of oats, and as a result of this it was found that nitrogenous manures gave the best return. In the publication of the report the unfortunate statement was made that this particular soil was apparently very deficient in nitrogen. Naturally, the farmer came to the conclusion that nitrogen in some form or other was the manurial constituent most required so far as his farm was concerned, and in the following season his mixture of manures applied to his turnip crop consisted very largely of sulphate of ammonia. The result, as was naturally to be expected, was that his crop of turnips was an almost entire failure. This led not only to a direct loss to the farmer himself, but had the secondary misfortune of prejudicing him against experimental work of any kind. This may appear to be rather an extreme case, but in the experience of the writer it is by no means an isolated one.

The objections just taken to the method of carrying out single plot experiments on one particular farm for a single season are often more applicable to so-called variety trials than to manurial trials, because with variety trials there are several additional factors that come into play. First of all, we have the origin of the seed. The origin of the manure, of course, is of comparatively little or no importance whatsoever, but in a variety trial it is absolutely necessary that the seeds have all been grown for two or three seasons on the same holding. It is a well recognised fact that changing cereal seed from one holding to another has a considerable influence on both the yield of grain and straw as well as upon the earliness of the crop. Unless, therefore, the seed used in a variety trial has been grown for some considerable time under exactly the same soil and climatic conditions, the difference due to the change made may quite well be very much greater than any difference due to any inherent character or characters in the varieties themselves. Further, it is practically useless to think of deciding on the relative values of varieties as the result of one single trial, even where the seeds have been grown for a time under similar conditions, because the change will more than likely affect the varieties very differently. It is frequently observed that a change of seed proves beneficial with one variety, but has the very opposite effect with another variety in the first season. In the second season, on the other hand, the results may be in the opposite direction. As a proof of this the writer gives below the results of a trial carried out by him with three different varieties of oats over a period of three years. The plots were triplicated, and the figures given below are the averages of the three plots in each case.

Variety.	*"A."* *Bush.*	*"B."* *Bush.*	*"C."* *Bush.*
1st Year . .	58	52	48
2nd „ . .	48	50	51
3rd „ . .	43	48	56

With a set of experiments carried on only for one season it would have been given out that the variety "A" was by far the best of the three, but quite evidently the use of such a variety would have led to a loss had it been sown on a large scale for a second season, and still more for a third season. On the other hand, while variety "C" gave a comparatively poor return in the first year, it improved in subsequent years, and gave a higher yield in the third year than "A" or "B." It was quite evidently the variety best suited to this particular holding.

It must be clear, therefore, that if the trials are carried out from season to season on different farms, no really valuable information can be got whatsoever as to the suitability of the varieties for any particular holding. We have no doubt that a great deal of loss is entailed on farmers through following the lessons of such incomplete trials.

Another objection of a different nature might also be taken to many variety trials carried out at the present time. There has, unfortunately, been created amongst farmers an appetite, as it were, for novelties, and every season there is a large addition of varieties, or so-called varieties, to every class of farm crop in order to meet this demand. The rate at which these are being produced is sufficient evidence in itself to make one suspect that many of such new varieties cannot be properly tested at all before being put on the market, and it is not surprising, therefore, to find that so many of them after a short time turn out comparative failures. Frequently they give exceptionally good yields in the first season, but this is very often due to the fact that only the very finest seed is sent out. The superlative quality on the part of the seed will, during the first season, counterbalance to a very considerable extent any adverse effect on the yield which the unsuitability of the variety for the soil might entail. The real value of such materials for any particular holding can be estimated only when they have been grown on that holding for a few seasons. When this is done it will be found that, in a great majority of cases, many of these varieties are of comparatively little value.

Some few years ago the writer bought a quarter of seed oats of a new strain which was being very highly recommended by the breeder. The seed was certainly excellent, but so was the price, viz. £8 per quarter. In the first season it gave a yield of 10 bushels per acre more than a home-grown variety with home-grown seed. The writer, therefore, used all the seed in the following year to sow about 10 acres. The season, it must be said, was not a particularly favourable one, but the yield was less than one-half what it had been in the previous year, and a very considerable loss was therefore entailed, as the home-grown variety, although not giving a yield equal to the yield in the first year from the novelty, was still quite satisfactory.

Such materials, therefore, should be tested for a long period of

years before any reports whatsoever are made as regards their qualities. They must be tested on different farms under different soil and climatic conditions for a period of not less than five or six years before it is possible to determine if they are any improvement on varieties already in cultivation, and particularly for what set of circumstances they are best suited.

The writer has the feeling that many of the variety trials as carried out at present, and the publication of the results of these, are merely advertising novelties about which little or nothing is definitely known.

In carrying out variety trials, it is very essential that we commence with pure varieties, and that they be kept pure throughout the whole course of the trial. Unless this is so, the results will be entirely unreliable, no matter what care may be taken in other directions, and we are afraid that the ordinary cultivator does not realise how easily his varieties may get mixed. Even two or three grains in one year may in three or four years amount to a very large percentage of the sample. That this is so is recognised when the farmer will at once reject for seed purposes a sample of grain that contains only one or two grains of the wild oat.

For example, if we sow a mixture of grain consisting of two varieties in the proportions of 95 per cent. and 5 per cent., and the one represented by the 5 per cent. suits the conditions better than the other, then at harvest time we might quite possibly be harvesting 80 per cent. of the one and 20 per cent. of the other. In the second year the same relative change in the proportions might take place, and it must therefore be evident that by the end of the third year we are not really carrying out a test with the variety we started with, but with an entirely different mixture altogether. At threshing time, therefore, the greatest possible care must be taken to see that the mill is cleaned out thoroughly after each variety has been put through, and as a general rule it is not convenient to do this in the thorough manner necessary with the type of machine usually found about the ordinary farm.

Similar objections might be taken to a great deal more of the field experimental work as at present carried out, but the writer hopes he has said enough here to show how inconclusive, and therefore useless, a great deal of it must be, carried out as it is in the present extensive and indiscriminate way.

He has nothing but admiration for the zeal, energy and abilities of those conducting this work, but is strongly of opinion that the whole system is wrong. What is really needed is that in every district or county there should be one or two well selected centres, where work could be carried out continuously under conditions with which the workers are perfectly familiar. Even then, however, the information got at such centres must be looked upon as being merely of value as a guide to the farmer, and not as a basis on which exact recommendations could be made. The individual farmer must, after all, decide for himself by actual trial on his own holding and under his own conditions what particular variety he must use or what system of manuring, etc. he must follow.

Real and permanent progress can be made only along the lines of encouraging the individual to carry out trials and think for

himself, and there is just the suspicion that the present system is really working in the opposite direction by encouraging many farmers to depend upon others doing what, after all, they alone can do for themselves.

Are Milk Record Association Results Accurate?

THE following article is contributed by A. C. M'Candlish, M.S.A., and A. M'Vicar, B.Sc., Milk Production Department, the West of Scotland Agricultural College.

The results obtained by any milk record society give estimated records for all the cows on test and not the actual yields of milk and butter-fat produced by the animals. This is necessary for the sake of economy. It is not practicable to weigh and test officially the milk of every cow in a commercial herd daily, and so in practice the milk record societies do this work at stated intervals. From a practical standpoint, therefore, it is well to have an idea of the degree of accuracy of the records obtained by the supervising societies.

In making a study of the work of the Scottish Milk Records Association with a view to determining the influence of certain breeding practices on production, it was thought well to ascertain the value of the records of the association as compared with the actual production of the animals. The records of a herd where the milk of all cows was weighed at each milking were obtained. The records of all cows calving in 1920 and remaining in the herd until they completed their lactations were used. The actual records of the cows were obtained from the daily milk weights and the estimated records were obtained by two methods. In making the estimations the first test of the year was put on a day taken at random and the subsequent tests were taken at 10 day intervals.

The two methods of estimation studied here have been used by the Scottish Milk Records Association and will be called the "old" and "new" methods. The old method was used until the end of 1914, while the new method has been in use since that time. The official instructions for applying the two methods of calculation are as follows:

Old Method.—For the first test of a lactation multiply the total quantity of evening and morning milk from each cow by the number of days which have elapsed since the cow calved, and on the second and each succeeding test multiply the quantity of milk by the actual number of days which have elapsed since the last test.

New Method.—For the first test of a lactation multiply the total quantity of evening and morning milk from each cow by the number of days which have elapsed since the cow calved, plus half the number of days in the average interval between tests. On the second and each succeeding test multiply the quantity of milk by the actual number of days which have elapsed between tests, thus regarding each day of test as the middle day of the period covered by the test.

In addition to calculating the records at 10 day intervals they have been calculated by both methods at 20 and 30 day

intervals, in order to determine the influence on the calculated record of the length of the interval between tests.

TABLE I.

Yields obtained by Various Methods of Calculation.

Cow No.	Actual Yield.	Estimated Yields.					
		Old Method.			New Method.		
		10 Day.	20 Day.	30 Day.	10 Day.	20 Day.	30 Day.
	Gals.	Gals.	Gals.	Gals.	Gals.	Gals.	Gals.
2	719	710	704	681	730	716	740
3	621	611	598	589	625	626	622
6	747	723	709	663	744	751	757
7	679	655	639	590	676	682	654
12	528	520	504	507	533	536	492
14	453	452	437	391	477	468	499
15	683	671	661	609	696	680	683
16	404	399	378	351	414	413	398
17	540	531	518	513	545	547	556
18	706	670	641	613	693	682	687
19	863	855	850	827	871	886	870
20	515	500	489	440	519	508	519
22	516	518	509	504	532	526	516
23	756	757	729	717	772	781	758
25	609	598	590	587	618	605	616
26	563	553	538	516	565	563	554
27	778	755	739	711	774	769	785
30	868	849	858	807	867	836	863
33	460	432	414	407	447	447	443
34	610	592	588	542	611	626	598
36	713	722	697	707	715	724	709
37	702	695	683	664	700	719	717
40	669	664	629	620	679	699	683
41	726	720	699	704	734	728	719
Average	642	631	617	594	647	647	643

The true average of the 24 records studied is 642 gallons, and the yields obtained by the old method of calculation at 10 day intervals show an average of 631 gallons or a decrease of 11 gallons, while by the new method of determination the average yield obtained is 647 gallons or an increase of 5 gallons from the true average record. These are variations from the true record of less than 2 per cent. in the case of the old method and less than 1 per cent. in the case of the new method of calculation, and are quite negligible, though the new method of calculation gives a somewhat better result than does the old.

It is important to notice not only the average results from the records studied, but also the variations obtained on calculating individual records by the various methods. In the case of the old method the variations run from a decrease of 36 gallons to an increase of 9 gallons, or a range of variation of 45 gallons. With the new method the variations run from a decrease of 13 gallons to an increase of 24 gallons, or a range of variation of 37 gallons. This again shows a slight advantage in favour of the new method of calculation.

TABLE II.

Comparison of Methods of Calculating Records.

Method.	Average Yield.	Variation from True Average.	Maximum Variation. Increase.	Maximum Variation. Decrease.	Range of Variation.
	Gals.	Gals.	Gals.	Gals.	Gals.
Old—					
10 Day, . .	631	-11	9	36	45
20 Day, .	617	-25	...	65	65
30 Day, . .	594	-48	...	93	93
New—					
10 Day, .	647	5	24	13	37
20 Day, .	647	5	25	32	57
30 Day, . .	643	1	46	36	82

On comparing the records obtained by testing at 10, 20 and 30 day intervals and calculating the results by the new method, it is found that the average records obtained are 647, 647 and 643 gallons respectively as compared with the true average of 642 gallons. These are increases of 5, 5 and 1 gallons for the 10, 20 and 30 day intervals and are of no significance, as all are variations from the true average of less than 1 per cent. The variations with individual records are as follows: from a decrease of 13 gallons to an increase of 24 gallons, or a range of variation of 37 gallons in the case of the 10 day records, from a decrease of 32 gallons to an increase of 25 gallons, or a range of variation of 57 gallons in the case of the 20 day interval; and from a decrease of 36 gallons to an increase of 46 gallons, with a range of variation of 82 gallons in the case of the 30 day interval.

In comparing the results obtained when the records are calculated by the new method, and the tests are at 10, 20 and 30 day intervals, it is found that there are no significant variations in the averages obtained, but as the interval between tests widens, the variations in individual records become greater. However, even where the interval is of 30 days duration, the variations in the individual records obtained by the new method of calculation are not great enough to injure the practical value of the results.

TABLE III.

Distribution Table for Variations in Yields as obtained by Various Methods of Calculation.

Method.	Variation in Gallons from True Yield. 0-10.	11-20.	21-30.	31-40.	41-50	51-60.	61-70	71-80.	81-90.	91-100.
Old—										
10 Day .	14	5	4	1	...	...	...	...	...	...
20 Day .	2	6	10	4	1	...	1	...	...	...
30 Day .	1	1	4	5	2	2	5	1	2	1
New—										
10 Day .	17	6	1	...	...	...	...	...	...	...
20 Day .	15	5	3	1	...	...	...	...	...	...
30 Day .	14	6	2	1	1	...	...	...	...	...

If the records obtained by testing at 10, 20 and 30 day intervals and calculating according to the old method be compared, it will be found that they are 631, 617 and 594 gallons respectively as compared with the actual average of 642 gallons. These are decreases of 11, 25 and 48 gallons from the true average. The variations with individual records are as follows: from an increase of 9 gallons to a decrease of 36 gallons in the case of the 10 day interval; or a range of variation of 45 gallons; in the case of the other intervals the variation was always a decrease, and was as great as 65 gallons with the 20 day interval and 93 gallons with the 30 day interval.

When the records are calculated by the old method, the average variation is less than 2 per cent. with a 10 day interval, but increases to about 4 per cent. with a 20 day interval and to over 7 per cent. with a 30 day interval. Though there is not a great difference in reliability between the two methods of calculation when there is a short interval between tests, yet the new method has the advantage. When, however, the interval between tests is increased, the reliability of the new method of calculating the records remains unchanged, while that of the old method is adversely affected. This becomes of greater significance when it is remembered that practically all milk record society tests are conducted at intervals of 21 to 28 days. In testing at such intervals the new method of calculation will give results that approximate very closely to the true records, while large variations, even up to about one hundred gallons, may be obtained if the old method of calculation is followed.

TABLE IV.

Average Length of Lactation Periods.

Method.	Length.
	Days.
True	265
Old—	
10 Day	261
20 Day	256
30 Day	251
New—	
10 Day	266
20 Day	265
30 Day	265

When the new method of calculation is used the results are quite reliable, and, further, about the same number of individual records show an increase as show a decrease. Consequently the chances are about even that a calculated record may be either slightly greater or slightly less than the actual record. On the other hand, when the old method of calculation is used, the chances are high that the calculated record will be less than the actual one. Of the records calculated by the old method all at 20 and 30 day intervals and all but 3 at 10 day intervals are less than the actual record. In other words the new method of calculation gives the cow an even chance while the old method put her under a handicap.

It will be seen, therefore, that the new method of calculation gives a much better approximation than does the old method. A study of the lengths of the lactation periods gives some explanation as to the cause of this. The true average length of the lactation periods is 265 days, and by the new method of calculation an average of 265 or 266 days is obtained, while with the old method of calculation the averages obtained are 261, 256 and 251 days when the intervals between tests are 10, 20 and 30 days respectively. That is, with the old method of calculation the length of the lactation period on the average will be shown as shorter than the true lactation by a period approximately equal to half the period between tests. This is simply due to the fact that the lactation periods end not all on a test day, but at all times from one test to the next and the average date of finishing will be mid-way between two tests. The new method of calculation allows for this and so gives a clearer representation of the production of a cow.

In practice the milk of a cow is not generally weighed until a few days after calving—when the colostrum period is finished and the milk is fit for consumption. In the records used here this was the practice, and in all the computations made the records have been calculated as from the day on which the milk was first weighed and not from the day on which the cow calved. If the records discussed here had been calculated from the dates of calving, the average lengths of them would have been increased by 5 days, both actual and calculated, as the cows were on the average calved 5 days before the weighing of the milk started. This would necessitate adding to the average production in each case 18 gallons, if the yield of this period were calculated from the average production at the first test. This amount would probably be somewhat too great, as a cow normally does not produce as much during the colostrum period as she does shortly afterwards. However, this discrepancy, when considered with the total production for the lactation, is small and of no practical significance.

Summary.—The method of calculating milk yields at present used by the Scottish Milk Records Association is quite satisfactory, and gives a greater degree of accuracy than the method formerly used. When the interval between tests is increased from 10 to 20 or even 30 days, the average record obtained for a herd will not be materially altered, though the variations in individual records will be somewhat greater than where there is a shorter interval between tests. With the old method of calculation the variations in the averages and in individual records become greater and are weighted against the cow. On the whole, the method at present in use for the calculating of records is very satisfactory and quite reliable.

Danish Hen-feeding Experiments.

THE following notes, contributed by Dan. W. Steuart, B.Sc. (Agric.), summarise Danish Report, No. 112 (1923), which deals with hen-feeding experiments conducted during the years 1915 to 1922:—

I. Previous experiments on heavy or light feeding (see this Journal, April 1922, p. 158) had indicated that Plymouth Rocks required about 3·4 ozs. of food when fed on a

grass run with the usual accompaniments of fresh water, shell, etc. Such hens in this experiment, which covered four years, were given 3·1 ozs. in one case and 3·7 in the other. In the winter the grass was supplemented with roots and lucerne chaff. The lighter ration produced 93 eggs per hen, against 103 for the heavier feeding. The heavier feeding produced heavier eggs. The average weight of the hens was about 5 lbs.

II. This experiment dealt with weighed ration and self feeding. Plymouth Rocks got 3·0 ozs. of food, part of which was fed as wet mash; in addition to this the second group had access to dry mash of the same composition, but all ground up and as much as they liked. Of this they ate on the average 1·0 oz., making 4·0 ozs. of total grain and meal. The experiment was done both with 1 year and 2 year hens. The regular weighed ration produced 73 eggs against 108 eggs. The free feeding also produced heavier eggs and heavier hens.

III. Here there were four feeding experiments with grain and potatoes; two with year-old hens and two with 2 year hens. The one group received a 4·0 oz. ration (partly as wet mash), and the other group got 2·3 ozs. of grain and 6·4 ozs. of cooked potatoes. As usual the hens got roots in winter and green stuff in summer. Potatoes did not do so well as grain. The eggs laid were only 110 against 120, the eggs were smaller and the hens put on less weight.

IV. These experiments were made to note the effects of feeding green stuff and no green stuff. At one centre 2 year Plymouth Rocks and at another both 1 year and 2 year Plymouth Rocks and Leghorns were used. One lot were fed in a grass run and got also as much as they could eat of green lucerne in summer and of lucerne hay in winter; the other lot were in grass-free runs and got no lucerne at all. Both lots got the same grain ration, and in addition got dry mash *ad lib.* but carefully weighed. An abundant supply of green stuff caused earlier laying, more eggs and heavier eggs. Lack of green stuff injured the health of the hens, specially, however, that of the younger hens.

V. Young hens which begin to lay early will generally lay more eggs in the first year than those which began late; young hens which lay many winter eggs will also generally lay many summer eggs. It will generally be good policy to reject all young hens which have not laid before March 1st. The following figures summarise seven years' work :—

No. of Hens.	Average No. of Eggs laid.						
	Nov.	Dec.	Jan.	Feb.	Before 1st March.	After 1st March.	Total.
36	7·9	12·2	11·3	13·1	44·5	133·2	177·7
181	...	7·4	13·6	11·6	32·6	133·1	165·7
236	...	...	7·9	12·1	20·0	124·1	144·1
138	...	...	...	7·9	7·9	116·3	124·2
127	...	...	...	...	...	97·0	97·0

VI. Young hens increase in weight till about the first of March, lose weight during the spring and increase slowly again during the summer and autumn—the food consisting of grain together with dry mash finely ground, to which the animals had constant access. The average weights each month from December to October were 3·76, 4·03, 4·38, 4·55, 4·38, 4·16, 4·14, 4·14, 4·20, 4·29, and 4·25 lbs.

VII. At Lundsgaard big hens ate more food than little hens, without, however, laying a greater number of eggs, thus:—

	Live wt. lbs.	*Grain ration.*	*Free ration.*	*No. of eggs.*	*Egg wt.*
Big hens .	4·8	2·3 ozs.	1·72 ozs.	141	2·06 ozs.
Little hens .	3·8	2·3 ozs.	1·45 ozs.	147	1·99 ozs.

The big hens got 2·3 ozs. and took 1·72 ozs; total, 4·02 ozs.

The little hens got 2·3 ozs. and took 1·45 ozs.; total, 3·75 ozs.

Tables are given showing the eggs produced and food eaten by different breeds. The average weight of the hens is also given.

THE following notes dealing with farm wages in Scotland and minimum wages in England and Wales have been contributed by Sir James Wilson, K.C.S.I.

Farm Wages.

Scotland.—In a statement recently issued by the Board of Agriculture giving the rates of wages for farm labour at present prevalent in Scotland, they have made a change in the system of calculating the value of the allowances given in addition to the cash wage, and have now adopted for all Scotland the following values:—House £6 per annum, oatmeal 20s. per cwt., potatoes £7 per ton, milk 1s. 6d. per gallon, coal 35s. per ton, board and lodging for single men 12s. 6d. per week. As a matter of fact the cash values of these allowances vary from one district to another and results so calculated can only be approximate, but the method is the best available.

As regards married men, the arithmetical averages of the statistics given work out as follows for all the counties of Scotland put together:—

Average Weekly Earnings of Married Men in Winter 1924–25.

	Cash.	Allowances.	Total.
	s. d.	*s. d.*	*s. d.*
Ploughmen	29 6	9 10	39 4
Cattlemen	30 3	9 10	40 1
Shepherds	29 2	10 8	39 10

From these figures it appears that the average weekly earnings of cattlemen and shepherds are much the same as those of married

ploughmen, and attention may be confined to the case of the married ploughmen, who form the most important part of the body of farm servants.

Married Ploughmen.—In most counties of Scotland the married ploughmen are engaged for a year from Whitsunday, and there no general change took place at last Martinmas in their cash wages. But in the central industrial area the married ploughmen are usually engaged either for a year or for six months every Martinmas, so that last November they had to make new bargains with their employers. After comparison of the information given by the Board's agricultural reporters with the information contained in the *Scottish Farm Servant* and other papers, I venture to estimate as follows the average weekly earnings of married ploughmen (1) last summer and (2) during the present winter:—

Average Weekly Earnings of Ordinary Married Ploughmen (excluding Grieves and Foremen).

County.	In Summer 1924.			In Winter 1924 25		
	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.
	s.	*s.*	*s.*	*s.*	*s.*	*s.*
Stirling	37	4	41	40	4	44
Dumbarton (Lower Clyde Valley)	38	4	42	39	5	44
Lanark („)	38	4	42	39	5	44
Renfrew („)	38	4	42	39	5	44
Ayr (North) . . .	37	5	42	38	5	43
Fife (North-East) . . .	28	11	39	30	14	44
Perth (South-East) . .	27	11	38	29	14	43
Forfar (South) . . .	28	11	39	28	14	42

According to this estimate, taking the arithmetical average for the above areas, the weekly earnings of an ordinary married ploughman have risen from 40s. 8d. (cash 33s. 11d., allowances 6s. 9d.) last summer to 43s. 6d. (cash 35s. 3d., allowances 8s. 3d.) during the present winter. The increase in the average cash wages is due to the rise conceded at last Martinmas, and the increase in the estimated cash value of the allowances is mainly due to the increased values placed upon potatoes according to the wholesale price current at the time the main crop was lifted (the assumed prices being £3, 10s. per ton for the potato crop harvested in November 1923 and £7 for that harvested last November), and on milk, which the Board of Agriculture reckon as averaging 1s. 6d. per gallon, while in my last year's report I took the wholesale value of milk on the farm as averaging 1s. per gallon for the whole year. The estimates are of course only approximate, but, so far as they go, they make the increase in the cash value of the weekly earnings of married ploughmen in the industrial area, as compared with last summer, 2s. 10d. per week (cash 1s. 4d., value of allowances 1s. 6d).

Owing to the rise in the assumed prices of potatoes and milk, the cash value of the allowances all over the country has increased,

and, if the available figures for the whole of Scotland be put together, the arithmetical average for last summer given in my report (published in the Board's *Journal of Agriculture* of October 1924) was 37s. 5d. (cash 29s. 7d, allowances 7s. 10d.), and is now, according to the Board's statement, 39s. 4d. (cash 29s. 6d., allowances 9s. 10d.). Probably the number of ploughmen receiving more than the arithmetical average is larger than the number receiving less, and it may be roughly estimated that at present for all Scotland the average weekly earnings of married ploughmen are about 40s., as compared with 22s. in summer 1914 and 55s. in summer 1920 and with 38s. last summer—an increase of 82 per cent. as compared with summer 1914. According to the *Labour Gazette's* statistics, the cost of living is now (January) 80 per cent. above what it was in July 1914; so that it would appear that on the whole the Scottish married farm servant is in a position to maintain his family at a standard of comfort equal to that which he had attained immediately before the war. If a married ploughman compares his earnings with those current in other industries, he should remember that, if he changed his occupation, he would have to pay a higher rent for a house than the value placed upon it in the above calculation, and much higher prices for oatmeal, milk and potatoes than the values assumed above. Moreover, in most other industries he would not have the same security of constant employment and constant wages with house-room for the year or six months for which he has made his present engagement.

Single Ploughmen — Except in the south-eastern counties, single men are generally engaged for six months at a time, and most of them had to make a new bargain last Martinmas. According to the Board's reporters their cash wages now average 23s. 8d. a week, compared with 22s. 2d. last summer—a rise of over 2s. per week, but the rate of rise reported varies considerably between different districts. The value of their allowances given by the Board averages 9s. 2d. a week, but the 12s. 6d. per week estimated as the cash value of board and lodging seems too low, and I would put the average value of the weekly earnings of single ploughmen at about 36s. a week (cash 24s., allowances 12s.), compared with 40s. for the married men. Many of the single men are comparatively inexperienced, and therefore get a lower rate of earnings.

England and Wales.—In England and Wales the Agricultural Wages Committees are now fixing minimum rates under the recent "Agricultural Wages (Regulation) Act." In those counties for which separate rates are fixed for horsemen, stockmen and shepherds the highest rates so far fixed are in Durham, where for stockmen and shepherds, who are householders, the minimum rate is 43s. for customary hours, and the rate for horsemen, who are householders, is 39s. for a week of 50 hours plus stable-work. In Middlesex the rate for stockmen is 41s. 3d. for 60 hours, while carters have a minimum rate of 38s. 6d. for 56 hours. In Surrey for stockmen, shepherds and horsemen the rate is 38s. 8d. for 60 hours. In Cambridge, Cumberland and Westmorland it is 37s. for customary hours, and in Denbigh and Flint 37s. for 61 hours. Among the lowest rates hitherto fixed for horsemen, stockmen and shepherds are:—Suffolk, 35s. 2d. for 50 hours in summer plus

duties necessary for the care of animals; Norfolk, 34s. 6d. after March for 50 hours plus stable-work; Gloucester, 36s. for 60 hours; Anglesey and Carnarvon, 35s. for 58 hours, and Merioneth and Montgomery, 34s. for 60 hours. It is to be remembered that these are *minimum* rates of wages, below which no man can be employed, and that no doubt there will be a tendency to pay somewhat higher rates to men who are better skilled than the average. Some of them also may at times earn a little more by working overtime.

In Scotland the rates of wages quoted above are meant to represent the *average* actual weekly earnings of ordinary married ploughmen, as the result of individual bargains made without any statutory minimum rate. They generally cover working hours averaging for the year rather over 50 per week, besides necessary stable-work, with little opportunity for earning extra wages by working overtime, as in harvest the customary working-hours are 60 per week. On the whole it seems probable that, although the Agricultural Wages (Regulation) Act will have the effect of raising the actual rates of wages in a number of the English and Welsh counties, the average English married ploughman will still be in receipt of a wage 2s. or 3s. less per week than the 40s. which I have estimated above as the present average weekly earnings of an ordinary married ploughman in Scotland. Moreover the married ploughman in Scotland is secure of employment and of a house for the year or six months for which he has made his engagement, whereas in a great part of England and Wales he is liable to lose his employment and his house on a week's notice.

For adult male workers other than horsemen, stockmen and shepherds the English Agricultural Wages Board have generally fixed minimum rates of wages for so many hours work per week, with additional rates for overtime. Among the highest rates fixed for such workers, who are not usually in charge of animals, are—in the Holland division of Lincoln, 36s. for 48 hours; Derby, 36s. for 54 hours; Cheshire, 35s. for 54 hours; Leicester, 34s. for 54 hours; Middlesex, 34s. 4½d. for 50 hours in summer and 33s. for 48 hours in winter; and among the lowest rates are—30s. for 50 hours a week in summer in Essex, Buckingham, Gloucester, Warwick, Wiltshire, Oxford. But the minimum wage for such men is in Berkshire, 29s. 2d. for 50 hours; in Norfolk, 28s. for 48 hours in winter and 29s. for 50 hours in summer; Bedford and Huntingdon, 29s. for 48 hours, and in Suffolk, 29s. 2d. for 50 hours in summer and 28s. for 48 hours in winter. In comparing these rates with the average weekly earnings of single ploughmen in Scotland, which I have estimated at 36s. a week, it is to be remembered that the English rates are minimum rates, and that there the adult worker can claim an addition to his minimum rate for any overtime worked, usually at the rate of about 9d. per hour; whereas in Scotland the single ploughman, who is generally engaged for a period of six months, is in charge of animals and has about an hour a day stable-work in addition to his field work, which averages for the year rather more than 50 hours a week, with little opportunity of earning anything above his fixed wage by working overtime.

Notes from Craibstone.

Mixtures for One Year's Hay.—In the great majority of cases where the land is laid down to grass for only one year, the grass being made into hay, the predominant constituents of the mixtures used are Italian ryegrass and red clover. Undoubtedly Italian ryegrass has the advantage of coming earlier in the season than any other grass, but it is a mistake to think, as many do, that it adds to the actual weight of the crop. A crop of Italian ryegrass is bulky in appearance, but it does not weigh at all so well as one would expect from this. Of course, where grass is required for early cutting in the spring or summer, then Italian ryegrass is undoubtedly the best of all, but if the crop is to be left to be made into hay at the ordinary season it certainly does not give the same weight as other grasses, like perennial ryegrass and timothy.

If a plant of Italian is compared with a plant of perennial, it will be found that the wall of the stem in the case of the former is much finer than in the case of the latter, and that, therefore, plant for plant, the perennial ryegrass, although not so tall and bulky looking, nevertheless weighs more than a plant of Italian ryegrass. Italian ryegrass, too, in order to give its best return requires a moister soil than the perennial ryegrass. So much is this the case, indeed, that it is practically useless to sow Italian ryegrass on soils of a lightish nature. As a general rule, however, where the system of farming is practised that contains only one year's grass, the soils are naturally suited for Italian ryegrass.

The principal direction, however, in which Italian ryegrass reduces the weight of the hay crop is in its effect upon the growth and development of the red clover. With its very early growth in spring, and its broad leaves, it shades out the red clover to a much greater extent than any other grass. That this is so has been proved beyond doubt in many experiments carried out throughout the North of Scotland, and this result is in accordance with experience elsewhere, as is seen from the fact that in districts where Italian ryegrass is largely used the amount of red clover generally seen in the hay is very small, even although large quantities of seed are sown.

This effect of Italian ryegrass is intensified where considerable dressings of nitrogenous manures are applied, as this grass responds very readily in spring to applications of such manures.

One would think, naturally, that grazing the new grasses in the springtime, and thus keeping down the early Italian, would help the red clover considerably, but the experience at Craibstone and elsewhere is that, while this helps to some extent, the injury is already done, as the Italian checks the growth of the red clover very largely while under the nurse crop.

Perennial ryegrass is, on the whole, a better grass therefore for hay than Italian ryegrass. It weighs better in itself and there is always much more red clover where it is used.

In making botanical analyses of our hay crops where a mixture is used for one year's hay and two or three years' pasture, it was very noticeable that there was a much larger proportion of timothy than would have been expected, and this suggested the use of timothy in mixtures for one year's hay. As the results of the trials

referred to below clearly show, a few pounds of timothy will add materially to the weight of the hay. The table shows the seeding and the weight of the crop got over four seasons from four different mixtures where the same amount of clover was used in each case.

Seeding per acre.

	1.	2.	3.	4.
	Lbs.	Lbs.	Lbs.	Lbs.
Perennial Ryegrass	20	10	16	...
Italian Ryegrass	...	10	...	20
Timothy	...	...	6	...
Red Clover	3½	3½	3½	3½
Alsike Clover	1	1	1	1
Average weight of Hay—cwts.	72	69	75	64

The seeding with perennial ryegrass and timothy has given the best crop, followed by perennial ryegrass. It is quite clear that the inclusion of Italian ryegrass has very materially affected the weight of the crop. In every season there was a very marked difference in the amount of clovers in the different plots, most being in plots 1 and 3. The greater weight of crop in plot 3 was due also to the timothy, a considerable quantity of this grass being present in the hay.

The weights per acre do not indicate the full relative values of the different methods of seeding, as the large amounts of clover in plots 1 and 3 add very considerably to their feeding value. At the same time, clovers tend to have a laxative tendency, and hay rich in clover is not so suited for horses doing fast work. Owners of hunters and racehorses prefer to use hay that contains practically no clover. The same objection, of course, cannot be made where the hay is to be fed to feeding and dairy stock and slow-working horses. If, therefore, clover is wanted in the hay, large quantities of Italian ryegrass should evidently not be used. If, however, red clover is not wanted, Italian ryegrass may be used. It seems absurd, however, to sow a large quantity of red clover seed and sow along with it a large quantity of Italian ryegrass to prevent the clover from growing.

A distinct advantage that Italian ryegrass undoubtedly has over perennial ryegrass is that it stands better. No doubt this is partly due to the fact that there is less red clover amongst it, and that it is the extra weight of red clover that pulls down the perennial ryegrass. The Italian ryegrass has no advantage, however, in this direction over timothy. The timothy stands very well and helps to keep up the perennial ryegrass, so that from this point of view the mixture of perennial ryegrass and timothy is almost equally as good as the Italian.

The aftermath was not cut, but it was distinctly seen that Italian ryegrass had undoubtedly the advantage over other grasses. On plots 2 and 4 there was a very marked superiority in the aftermath from the point of view of a good mixture of grasses and clovers. In the perennial ryegrass plot the aftermath was almost entirely clover, while plot 3 was intermediate.

Census of Agricultural Production.

THE Board of Trade is now engaged in taking a census of production in Great Britain and Northern Ireland, and, as on previous occasions, has asked the respective Departments of Agriculture to deal with the census so far as it relates to agricultural production. This is the third occasion on which such a census has been taken. In 1908 the then Board of Agriculture and Fisheries dealt with Great Britain as a whole, its report being published in 1912. The second census, so far as Scotland was concerned, was taken by the Board of Agriculture for Scotland in 1913, but the outbreak of war prevented the completion of the tabulation and no report was issued.

The Board prepare annual estimates of the produce of the principal field crops—wheat, barley, oats, beans, hay, potatoes and roots. This year, in order to present a complete statement of the output of Scottish agriculture, the returns will include meat, dairy produce, wool, poultry, eggs, vegetables, fruit and honey. The necessary particulars will be obtained partly by means of supplementary inquiries in the schedule for the Annual Returns of Acreage and Live Stock, which will as usual be taken on 4th June, and partly by means of special schedules issued later to those concerned.

Public interest in agricultural affairs has grown very much during the last ten years, and the economic position of the agricultural industry (or industries) has recently been the subject of much discussion. In view of the importance of the census, it is hoped that farmers and small holders throughout Scotland will assist the Board by furnishing as fully as possible the information asked for. Individual schedules are treated as strictly confidential and are used only for obtaining general statistical information. These results cannot, however, be reached without the co-operation of the thousands of occupiers of agricultural land to whom the Board's inquiries will in due course be addressed.

Agricultural Conditions.

THE weather conditions during December were generally favourable for outdoor work, and good progress was made with ploughing. On the mainland mild and open weather continued well into January, and cultivation proceeded satisfactorily in most districts. In the Western Islands and some other western districts, however, rain storms were prevalent during the whole month, and in this area comparatively little progress was possible with any farming operations. In February unsettled weather was general, rain was frequent in all districts, while snow occurred locally. Farm work of every description could be carried out only with considerable difficulty, and in some areas ploughing had to be suspended owing to the waterlogged condition of the soil. Outdoor work was fairly well forward at the beginning of March in the northern and north-eastern districts, but elsewhere operations were more or less in arrear, varying according to the conditions prevailing locally.

The sowing of winter wheat was almost completed by the end

of December. The mild weather conditions during January and the absence of frost were favourable for growth, and the plant was then reported to be vigorous, healthy and thick on the ground, especially in the case of early sown fields. Owing to the continuous rains in February, however, the braird in some districts lost colour. From south-west Forfar, central and south-west Perth and Berwick it was reported that the condition of the crop at the beginning of March was barely up to the average. No actual statistics of the acreage sown are yet available, but according to preliminary estimates made by the Board's crop reporters, the area under winter wheat is likely to show a slight diminution as compared with last year.

The reports on the condition of last year's potato crop are varied. At the end of February the crop was in a fairly satisfactory condition in the east and south of Scotland, and in most of the western districts the tubers were reported to be healthy, but in Skye the crop had not kept well and disease was much in evidence. In the northern districts, especially in Orkney, rot and disease were prevalent, and potatoes showed growth when taken from the pits.

Ewes generally wintered well, and at the beginning of March they were reported to be in good condition in most districts. Pasture has been unusually plentiful, and flocks have benefited by the mild conditions prevailing during the greater part of the winter. In south-west Fife, Berwick, South Ayr, Kirkcudbright and Wigtown, however, ewes lost condition to some extent, being rather lean and soft, while in Islay and Jura the death-rate had been above the normal, and in these districts the lambing prospects were rather uncertain. At the beginning of March lambing had begun in several districts, mostly amongst special flocks. The fall of lambs was reported to be up to the average, but the wet and cold weather during February was not conducive to the progress of the lambs. In Stirling the crop of early lambs was stated to be about 30 per score of ewes.

The supply of turnips has been short in many districts, especially in Stirling, North Ayr and Central Perth. In some southern districts turnips left in the fields grew throughout the winter, and were quite sound at the end of February. Other keep was sufficient in most areas, straw being abundant, especially in the eastern counties. In Harris and Uist, however, the stocks of all keep have fallen very low.

The supply of regular workers is generally ample for requirements Skilled workers are, however, rather scarce in Kincardine, while there is a shortage of single men in Dumfries and of drainers in Wigtown.

RECENT PERIODICAL LITERATURE.

A number of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins and to the original publications quoted therein may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

The Influence of Rainfall on the Yield of Wheat at Rothamsted. *Fisher, R. A., Philosophical Transactions of the Royal Society of London, Series B, Vol. CCXIII. London*, 1924.—The article is a study by a mathematician of statistics relative to rainfall and its influence on wheat yield.

The rain data of Rothamsted have been analysed for 65 years; there are indications that wet years tend to occur in spells; a continuous and progressive change is observable in the distribution of the rain through the year; in other respects the sequence appears to be fortuitous. Rainfall changes account for only a portion of the slow changes observed in yields.

Curves showing the average effect on yield for each additional inch of rain throughout the year have been obtained for 13 plots of Broadbalk wheat field which have been under uniform treatment since 1852 On all plots dry weather is beneficial. A detailed comparison of plots indicates the predominant influence of the effect of rain in removing soil nitrates; the cause of other well-marked features cannot safely be asserted without further research.

Studies in Crop Variation. *Mackenzie, W. A., Journal of Agricultural Science, Vol. XIV, Part 3. London*, 1924.—The results of a statistical analysis of the yield of dressed grain from the Broadbalk Wheat Field, Rothamsted, were published in 1921 by R. A. Fisher (*Jour. Agri. Sci.*, II., Part II., 1921) and the present paper gives the results of a similar analysis of the Hoos Barley Field of the same Station. Thirteen plots have received the same manurial treatment since 1852, and these were selected for analysis, the examination extending over the 70 years, 1852-1921.

The object of the study was to determine the slow changes which have taken place in the mean yield of these plots, and to indicate the relationships between manurial treatment and mean yield and deterioration respectively.

The results obtained are summarised as under:—

(1) Of the three sources of nitrogen, rape cake gave the highest mean yields in the absence of superphosphate; nitrate of soda gave results significantly better than ammonium salts

(2) Superphosphate is of importance to the barley crop, giving greatly increased yield.

(3) Sulphate of potash seems to have an adverse effect on the barley yield.

(4) The deterioration of the barley plots is much greater than the wheat plots. Part of the diminution in mean yield may be due to slow changes other than deterioration.

(5) The mean annual percentage diminution is least on those plots in receipt of superphosphate, and emphasises the importance of phosphoric acid not only in increasing the mean yield, but in maintaining the fertility of the soil.

(6) Barley is more variable than wheat and is more subject to the influence of meteorological conditions.

(7) The slow changes other than deterioration are relatively unimportant and seem closely connected with manurial treatment.

Effects of the Modified Hot-Water Treatment on Germination Growth and Yield of Wheat. *Tapke, V. F., Journal of Agricultural Research, Vol. XXVIII., No. 1. Washington, D.C.*, 1924.—The growth in the use of the modified hot-water treatment for control of loose smut of wheat (*Ustilago tritici* Pers.), caused inquiries concerning the effects of the treatment on the germination, growth and yield of wheat. The available literature did not fully answer the questions, and the author, in consequence, carried out a series of investigations to supply the information. During the work it was noticed that seed coats were frequently broken, owing to injury received in machine-threshing.

Seed germination tests carried out on moist blotting paper cannot be used

to determine accurately the effects of treatment on germination of seed when sown in soil.

The hot-water treatment reduced germination of wheat seed to nearly zero when the seed coats were broken over the embryo. Reduction also occurred when the seed coat was broken over the endosperm.

Seeds with unbroken coats were retarded by treatment, but there was little or no reduction in germination.

Widely different weather conditions during the period between ripening and harvesting of seed had a marked effect on the amount of injury sustained by seed coats in threshing, and hence in the injury sustained by the seed from treatment.

The bushel weight of wheat grown from heated seed was not appreciably greater than that grown from untreated seed.

In each of the three years of the experiment, wheat grown from untreated seed outyielded that grown from treated seed.

Manuring Peat Soils. *Hansen, J., Tidts-skrift for Planteavl, Vol. XXIX., Part* 1, 1923.—These experiments were carried out at the Askov Experiment Station on high peat moors where the peat was 4 metres in depth.

Drainage Experiments.—The draining was effected by means of open ditches, 5·7 m., 11·3 m. and 22·6 m. apart, and 63 cm., 94 cm. and 127 cm. deep. The highest yields of cereals and leguminosæ were obtained when the distance between the ditches was 11·3 m.; lower yields were produced where the drains were 5·7 m. apart, and 25 per cent. less with an interval of 22·6 m. On the other hand, the best crops of hay were grown where the two widest spaces were left between the trenches.

Liming and Marling.—Carbonate of lime was applied at the rates of 18,000 and 36,000 kg. per hectare, the best results being obtained with the larger amount in the case of vetches, rye and oats, and with the smaller quantity in that of mixed cereals (barley and oats).

Lime and marl were equally efficacious when they were applied to peat soils that had been spread with a layer of sand 5 cm. deep. If the sand was 2·5 cm. thick, the crop yield was 8 per cent. higher when marl was used, while it was 33 per cent. higher when marl was applied without any sand.

Nitrogenous Manures.—Excellent results were obtained by the application of nitrogenous manures to high peat moorland cropped with cereals and gramineae, an increased yield of 28 to 30 per cent. being reported.

A New Method for the Utilisation of Farm Manure. *Kron, O., Die Technik in der Landschaft, Year* 5, *No.* 1. *Berlin,* 1924.—Although nitrogen is the most expensive fertiliser and constitutes the most valuable part of farm manure, 30 per cent. of this substance is lost in the dung-heap even in well-managed farms. Further, it has been found by experiment that, when the manure has been dug in, only 25 to 70 per cent. of the initial nitrogen is used by the crop. Thus it may be said that under the most favourable conditions barely 17 per cent. of the initial nitrogen of the dung is used by the plants. Hitherto, efforts have been directed to decreasing the losses of nitrogen that take place in the manure-heap, but it would have been far more useful to try and increase the utilisation of the nitrogen by plants as is shown by the preceding figures. If all leaching from the dung-hill were prevented, only 25 per cent. of the nitrogen could be used, whereas if the crops turned to full account the manure applied to them 70 per cent. of the initial nitrogen would be utilised. Thus, the increase would be 25-17·5 = 7·5 per cent. in the first case and 70-17·5 = 52·5 per cent. in the second.

Dr. Krantz has devised a method for improving the quality of farm-manure.

Fresh dung applied to plants has a negative effect, viz., it decreases the yield owing to the denitrifying action of bacteria. For this reason the manure is left to decompose, or ferment, on the dung-heap or the field. The object of the Krantz process is to regulate this fermentation, which it does by: (*a*) rendering the insoluble proteins available for plants; (*b*) destroying the denitrifying bacteria: (*c*) arresting fermentation after these two objects have been attained. As a result of this process the dung keeps well, does not part with any of its nitrogen, and supplies to the plants substances that are easily assimilated, thus greatly decreasing the losses on the field.

The manure is piled up on a moderately high heap without however being

pressed down: this allows of rapid fermentation with great rise of temperature. When a certain point is reached, the manure is compressed, so as to drive out a considerable portion of the air. This lessens the fermentation. The pressure is kept up by piling fresh dung upon the old; in this way, the heat of the first layer cannot be lost, and any straw that has escaped fermentation so far is brought under chemical and biological influences. The great heat which still persists in the interior of the heap also aids in promoting thorough fermentation. Krantz decided that this pressure, combined with the retention of the internal heat of the mass, could be employed in the preparation of green manures, and found that the crops not only benefited directly from the application of the manure thus treated, but were entirely free from weeds; therefore the process is of the utmost value to farms poor in live-stock and to arable farms.

The Krantz method has been adopted on a large scale since the autumn of 1920 on the Konradsdorf estate at Stockheim (Hesse, Germany). The objections to the process are as follows:—

(1) A large staff is needed.

(2) Much heat escapes from the manure brought hot from the stable: the irradiation takes place from the upper layer and the sides of the heap and is shown by the lengthened fermentation.

(3) Heat losses occur subsequent to fermentation. These are considerable, since after more than 6 months the temperature of the interior of the heap was still 40°C.

(4) The necessity of making the heap in a pyramidal form in order to insure its stability and prevent the loose layers from slipping.

(5) Owing to the staircase construction of the heap, insufficient pressure is exerted on a large part of the dung, which much interferes with the process of fermentation.

All these defects can, however, be remedied by the use of a manure elevator and by piling the dung in silos. It is necessary that the silos should be constructed in such a manner that the manure can be easily, quickly and simultaneously removed through openings that do not allow the heat to escape, the light to penetrate, or the contents to slip. The only means to insure all these results is to have a fixed frame with compartments separated by movable divisions.

The author describes the silo constructed and patented by him and gives numerous diagrams to show its working.

Excellent results have been obtained from the application of dung prepared in the silos. Krantz manure is said to be twice as efficacious as the ordinary product.

Definitions of Terms and Interpretation of Results of Analysis.

Journal of the Association of Official Agricultural Chemists, Vol. VII., No. 3. Washington, D.C., 1924—At the meeting held this year the Committee dealt with the following products:—

Basic slag.—This must be finely ground and should not contain any foreign material introduced after its manufacture. It must contain, at least, 12 per cent. of phosphoric acid (P_2O_5) of which 80 per cent. is soluble in 2 per cent. citric acid (Wagner's method). Slags not fulfilling these requirements must be classed as low grade products.

Lime.—Should be applied in a form capable of neutralising soil acidity to the same extent as the oxide, hydroxide, carbonate, etc. of magnesia.

Dry fertilisers, whether ground or crushed, should not contain any other ingredients than those specified.

Fertilising salts.—This term is applied to potassic salts with a high percentage of chlorides and 20-30 per cent. of potassium (K_2O).

Magnesio-potassic sulphate should not contain less than 25 per cent. potassium (K_2O), 25 per cent magnesium sulphate and 2·5 per cent. of chlorine.

Organic nitrogen in fertilising mixtures.—This can only be estimated by the neutral (Street) or the alkaline (Jones) permanganate method when the water insoluble nitrogen amounts to ⅓ or more of the total nitrogen. The quantity of nitrogen is sufficient if, at least, ⅓ of that found is water-soluble. The activity of the insoluble nitrogen must be 50 per cent. or more with alkaline permanganate, and 75 per cent. or over with neutral permanganate.

The Availability of Phosphoric Acid in Basic Slag Phosphates. *Journal of the Association of Official Agricultural Chemists, Vol. VII., No. 3. Washington, D.C.*, 1924.—The American Association of Official Agricultural Chemists appointed a Committee in 1911 for the purposes of collecting data on the availability of the phosphoric acid in basic slags and of testing Wagner's method of determining the said availability. The experiments were made in pots and in the field at ten Agricultural Experiment Stations and on different soils The details and results are given in the report.

Four types of basic slag contained a very available form of phosphoric acid and gave satisfactory results as to crop yield and quantity of phosphates.

The researches proved the efficiency of Wagner's analytic method in the case of slag and of the neutral citrate of ammonia method in that of superphosphates.

The Phosphoric Acid Problem in Germany. *Niklas, H., and Scharrer, K., Chemiker Zeitung XLVIII, Nos.* 29-30. *Cothen*, 1924.—The authors first describe the agricultural problems that post-war Germany is called upon to face, and show the extent to which the country is indebted for its supply of nitrogen (the motive power of all agricultural activity) to the Haber-Bosch, Ostwald and Schoenherr processes for the fixation of atmospheric nitrogen in the form of ammonia, or according to Frank Caro, in that of calcium nitrate.

They then pass on to consider how Germany stands as regards potassic fertilisers (necessary for acid soils), but it appears that the rich deposits of potassic salts existing in the country, especially at Stassfurt, preclude all anxiety on this account.

The phosphoric acid question is very much more serious, since nearly all the phosphatic deposits are situated abroad. The authors give the names of a few factories using German phosphates for the production of fertilisers, and state that crude phosphates are now frequently applied directly to the land, since Tacke and Neitmar maintain that all that is required is that the phosphoric acid in the fertiliser should be in a form capable of being displaced by the carbon dioxide of the air, the soil acids and the acids of the plant roots. This hypothesis is, however, still under discussion, and it is possible that the application of crude phosphates may have the fatal effect of making the soil acid.

Other investigators have suggested mixing the crude phosphate with powdered sulphur, in which case the phosphoric acid would be displaced by the sulphuric acid liberated by the oxidation of the sulphur. Satisfactory results have been obtained by Lemmermann with the so-called colloidal form, viz., crude phosphate mixed with $\frac{3}{8}$ of silicic acid. The true solution of the phosphoric acid problem would, however, seem to be the discovery of new deposits of phosphatic minerals in Germany, although in the future it may be possible to obtain access to the deposits of phosphates which exist in Russia, but these vary greatly in value from the standpoint of the agricultural chemist.

"Clumina," a New Fertiliser. *Lo Monaco, D, Le Stazioni sperimentali agrarie italiane, Vol. LVII., Parts* 4-5-6. *Rome*, 1924.—From observing the effect of asphyxiating gases on plant and animal substances, the author obtained the idea that chlorine gas might be employed for agricultural purposes, especially for stimulating seed germination. New seeds after having been gassed for a short time, especially in the case of peas, soon germinate and send out a radicle and long plumule. Wheat and bean seeds subjected to the action of chlorine were found to germinate sooner than the controls and to flower and fruit more freely. There was also a great difference between the underground and the aerial parts of wheat plants that had been treated, as compared with the control specimens.

The author discovered that vegetable soil after being treated with gas could be employed as a fertiliser on land sown with wheat. This fertiliser, which he calls Clumina, has given satisfactory results. In experimental trials on wheat, the author advises the application of 1 to 2 kg. of Clumina per 100 sq. metres. The fertiliser should nearly all be spread at sowing-time, only a small part (less than $\frac{1}{4}$) being reserved for dressing the crop before the spring. The author has gassed other substances besides vegetable mould, and found that the more nitrogen they contained the higher their fertilising property became.

The North of Scotland College of Agriculture,

MARISCHAL COLLEGE,

ABERDEEN.

Winter Session - October to March
Summer Session - April to June.

Qualifying Courses for B.Sc. (Agr.), University Diploma in Agriculture, Residential Course in Rural Domestic Economy for Girls at Craibstone, &c.

CALENDAR giving full particulars of Courses of Instruction; Syllabus of Experimental Work; Particulars of Advisory Work undertaken by the College; and Prospectus of Craibstone School of Rural Domestic Economy, may be had on application to—

A. A. PROSSER, ***Secretary,***
Crown Mansions,
41½ Union Street, ABERDEEN.

The West of Scotland Agricultural College,

GLASGOW AND KILMARNOCK.

THE CLASSES in Glasgow afford a Complete Course of Instruction in Agricultural Science, and qualify for all the higher Agricultural Examinations in Britain.

Session—October till March.

The Dairy School at Kilmarnock is open from April till October. Practical Instruction in Butter and Cheese Making is given, and Pupils are prepared for the N.D.D. Examination. The Poultry Department is open all the year round.

JOHN CUTHBERTSON,
Secretary.

6 BLYTHSWOOD SQUARE, GLASGOW.

ROYAL (DICK) VETERINARY COLLEGE,

EDINBURGH.

***Principal*—O. CHARNOCK BRADLEY, M.D., D.Sc., M.R.C.V.S.**

AFTER attendance on complete courses of instruction in this College, Students may proceed to the Examinations for the Diploma of Membership of the Royal College of Veterinary Surgeons (M.R.C.V.S.).

Students of the College may also present themselves for the Degree of Bachelor of Science (B.Sc.) in Veterinary Science, conferred by the University of Edinburgh.

Students are eligible for Bursaries granted by the Education Authorities of Counties and certain Burghs of Scotland.

A copy of the College Calendar may be obtained on application to—

A. C. DOULL, C.A., *Secretary and Treasurer.*

Good for CURBS, SPLINTS, CALLOUSED, or HARD SWELLINGS.

YOU RUB IT IN.
THE ESSENCE does the Rest.

2/- & 3/6
Of all Chemists.

Use WILEY'S CHEMICAL ESSENCE for LAMENESS in HORSES.

2/- & 3/6

Made only by—
F. E. ROOKLEDGE,
EASINGWOLD, YORKS.

Used for 80 YEARS with Success.

Phosphates in Morocco. *Annales de l'Institut Colonial de Bordeaux, March* 1924. *Bordeaux.* — The output of Moroccan phosphate reached 190,000 tons in 1923 as compared with 80,000 tons in 1922 and 8000 in 1921. The beds investigated at present, between El-Bouroadj and Oued-Zem, are about 80 km. in length and 50 km. broad, and the phosphatic deposits have a thickness of from 25 to 50 cm. If the output were increased ten-fold, it would take several centuries to exhaust the El Bouradj deposits.

Inspection of Commercial Feeding-Stuffs. *Bulletin* 209, *University of New Hampshire, U.S.A*, 1924.—The Bulletin was compiled by the Commissioner of Agriculture for the State Department of Agriculture in 1923. The first 12 pages deal with the quality of feeding-stuffs, classification, meaning of chemical analysis, digestibility of foods, method of using tables in making up cattle feeds, suggestions in purchasing feeds, etc. The remainder of the book is entirely composed of tabulated analyses of practically every feed used for cattle, pigs and poultry.

Results of Experiments on Dairy Cows in Denmark. *Frederiksen, L., Meddelelse fra Forsoglaboratoriet Husdyrbnings-afdeling udgivet af den Kgl. Veterinaer og Landbohojskoles Laboratorium for landokonomiske Forsog, pp.* 1-40. *Copenhagen,* 1923. -The chief object of these extensive tests was to determine as accurately as possible the yield of a cow by means of periodic weighings and analyses. The results obtained by a provisional inspection of the large mass of material gave the following results :—

(1) Milking has a very perceptible influence on milk yield.

(2) The daily variations in the milk and butter yield are very considerable, even in cows that receive the same food and treatment.

(3) The fat content gradually diminishes at the beginning of the lactation period, then remains fairly stationary till the end of that period, when it rises to a high percentage.

(4) Tests made at intervals of 10, 14 or 21 days give a figure for the total yield that is sufficiently accurate for all practical purposes.

(5) The calculations made by the Local Testing Society were about 5 per cent. higher than the actual yield as found by daily investigations.

Rate of Milk Secretion as Affected by an Accumulation of Milk in the Mammary Gland. *Ragsdale, A. C, Turner, C. W., and Brody, S., Journal of Dairy Science, Vol. VIII., No.* 3. *Baltimore,* 1924.—The object of the present study is to show the effect on milk secretion caused by an accumulation of milk in the mammary gland, and to prove the advantages of the frequent milkings advised by dairy experts.

In their experiments, which lasted about three months, the authors used 2 Jersey and 2 Ayrshire cows. The experiment period was divided into sub-periods of three days experimentation and three days rest.

The animals were milked regularly morning and evening at 5 o'clock. During the first sub-period, there was an extra milking at 6 o'clock in order to obtain the milk secreted during the first hour. During the second period the extra milking was done at 7 in the morning, so as to get the milk secreted during the two hours subsequent to the regular milking ; this method was continued till the 36th hour, the regular 5 o'clock morning or evening milkings being suppressed when necessary.

The results obtained allow the following conclusions to be drawn :—

(1) The rate of milk-secretion per time unit is regulated by the amount of milk accumulated in the mammary gland, or by the length of time intervening between the two milkings. If the amount of milk secreted in the course of the first hour is represented by 100, the amount secreted during each of the following hours is approximately 95 per cent. of the milk secreted in the course of the preceding hour.

(2) Under the experimental conditions, it was estimated that a cow which is milked three times daily will give 110 per cent. of the milk secreted by a cow that is only milked twice daily ; while a cow milked four times daily will yield 116 per cent. of the milk obtained from a cow only milked twice daily.

The data prove that the fat percentage and total solid matter content fall with the prolonging of the interval between two milkings, provided the time

does not exceed 14 to 16 hours. After that length of time there is a gradual increase up to 36 hours.

Other data collected at the Station would, however, seem to show that there is a connection between the fat-content of milk and the time that has elapsed since the animal has been fed, and that this relation, rather than the interval between the two milkings, is the factor accounting for the variation in the milk composition.

Condensed and Powdered Buttermilk for Dairy Calves. *Eckles, C. H., and Gullickson, E. W., Journal of Dairy Science, Vol. VII., No.* 3. *Baltimore,* 1924.—The experiments of the authors were undertaken in order to ascertain whether it is possible to insure normal growth in calves by substituting condensed or powdered buttermilk for skim-milk. In the first experiment there were two lots; the first of these was composed of a pure-bred male Jersey calf and a half-bred Guernsey heifer, both of which were fed condensed or powdered buttermilk up to the age of 105 days. The second group consisted of 2 half-bred Guernsey heifers and one pure-bred Jersey bull-calf weaned when 150 days old.

In the second experiment, 5 half-bred Holstein calves were given powdered buttermilk up to the age of 70 days and two others were fed on the same food until 150 days old.

The buttermilk was derived from cream neutralised before churning by the addition of calcium salts. Before being fed to the calves the buttermilk was mixed with sufficient hot water to give it the average composition of fresh buttermilk.

The calves were fed whole milk for 10-15 days and the buttermilk was substituted gradually as a supplementary ration; the calves received lucerne hay *ad lib.* and a concentrate composed of maize flour + wheat bran + linseed cake (4 : 1 : 1).

The increase in weight was ascertained every 10 days, and the increase in height every 30 days.

From the detailed results of the experiment it may be concluded that, as a general rule, calves reared on buttermilk grow in a very satisfactory manner; this was especially noticeable in the Jersey-Guernsey lot weaned at 150 days The calves weaned at 70 days lost ground a little and were not able to make the loss good until they reached the age of 6 months. The difference in weight was, however, not enough to justify economically a longer period of buttermilk feeding.

During the experiments, the calves were free from all diseases and digestive troubles. They seemed to prefer buttermilk to whole milk. No diarrhœa supervened, although a little more fæcal matter was expelled than when the calves received whole milk, but this increased rather than diminished the vigour and vitality of the animals. The calves had glossy coats, looked well and were as large and healthy as the other calves on the farm that had been reared in the usual manner.

Foot-and-Mouth Disease in Sheep. *Moussu, G., Journal d'Agriculture pratique, Year* 88, *Vol. I., No.* 7. *Paris,* 1924.—Foot-and-mouth disease rarely occurs in adult sheep, or goats, in the severe form in which it attacks cattle; further, it is seldom accompanied by the characteristic symptoms. Owing to foot-eruptions being the best-known and frequently the only manifestation of the disease in sheep and goats, foot-and-mouth disease is in their case often confused with foot-rot.

When mouth lesions appear in these animals, they take the shape of small vesicles of short duration that arise on the pad, or on the inner surface of the lower lip. Copious salivation, which always occurs in cattle, is seldom present, and the sick animals only exceptionally suffer from total loss of appetite.

The foot lesions are, on the other hand, more characteristic in sheep, although the vesicles are often limited to the spaces between the digits and rarely extend to the external circumference of the hoof, or to the heel region.

If numerous abortions occur during a few weeks in ewes in an advanced state of gestation, this trouble is due to foot-and-mouth disease and not to contagious abortion; in the same manner, a high mortality among the lambs of a few days old that show no pathological symptoms is to be attributed to foot-and-mouth disease.

Unlike foot rot, which develops slowly in one sheep after another, so that a long period elapses before a large number of individuals are attacked, foot-and-mouth disease is extremely contagious, and though its effects are slight in the case of adult sheep, the lambs born during the course of an outbreak of the disease die off in large numbers from a septicemic form of the disease which is not accompanied by apparent lesions or vesicles in the mouth or on the foot. Lambs born of dams that have just had foot-and-mouth disease benefit by the immunity acquired by the ewe before lambing.

It is possible to prevent the loss of the young animals if foot-and-mouth disease is prevalent during the lambing season, or a little after. The blood, or blood-serum of individuals that have lately recovered (a few days or even some weeks previously), like that of hyperimmunised animals, possesses preventive and curative properties. Therefore blood taken from animals that have recovered, if kept uncoagulated, can be injected into infected individuals, or newly-born lambs, with the result that they frequently remain immune, or in any case contract the disease in a benign form; 50 cc. of blood from animals that have recovered is a suitable dose for adult sheep and 15-20 cc. is sufficient to insure lambs from infection.

A veterinary is required to take the blood and make the injections.

Artificial Incubation of Eggs. *L. B. Atkinson in Jour. Roy. Soc. Arts, Nov. and Dec.*, 1924.—In an exhaustive account of the scientific principles of artificial incubation the author deals with the various types of incubators as well as with the factors involved in incubation, such as moisture, temperature, access of air, amount of carbonic acid gas and so on Carbonic acid gas may be regarded as a poison, but the margin of safety is comparatively great Up to a maximum of 50 parts to 10,000 the percentage of fertile eggs which hatch is not affected; up to 200 parts there is a decrease in hatching which is slight; but beyond 200 parts per 10,000 the decrease is rapid. The average amount of carbonic acid gas in air expired by a human being is 350 parts in 10,000. The humidity factor is important in incubation. In tests covering nearly 10,000 eggs it was found that 15 to 20 per cent. humidity gave only 48 per cent. hatches; 20 to 30 per cent. gave 60·6 per cent. hatches, and the hatching reached its best at 50 to 60 per cent. with 69·3 per cent. of hatches. This is higher than the humidity actually found in a hen's nest under natural conditions, but is probably counteracted in effect by the greater movement of the air in an incubator. In spite of all the corrections made on account of such influences, it was still found that incubators do not produce so high a percentage of successful hatchings as does a hen, nor are the chicks, over all, so vigorous. Of chicks hatched by the hen, experimenters at the Oregon experimental stations found that at 4 weeks the mortality with hens brooding was 2·2 per cent., with artificial brooding 33·5 per cent.; but of chicks hatched by incubator the corresponding rates of mortality were 49·2 per cent. and 33·5 per cent. There is a difference here which indicates some important missing factor in artificial incubation. The author considers that the missing factor is a difference in temperature which occurs in the naturally incubated egg, but is absent from that in the incubator. In a nest the upper part of the egg, in contact with the hen's body, is at a higher temperature than the under surface, the difference being as much as 14°F. to 20°F. In the human subject Dr Leonard Hill has found that a high body temperature associated with cool surface temperature and the inhalation of cool air greatly increases circulation and food metabolism, and the author is of opinion that something of the same kind may apply to chicks. He suggests that the great losses from "dead in shell," generally accompanied by the presence of the yolk outside the body at a period when it should have been absorbed, arise from defective metabolism. It is interesting to note that when Mr Atkinson endeavoured to imitate the natural conditions of incubation, by producing a differential temperature between the upper and lower surfaces of the eggs by means of a rubber sheet laid upon them, he obtained remarkable results. An incubator which rarely hatched above 55 per cent. of the eggs placed in it, when thus modified, raised the percentage of hatching of fertile eggs to 95, and of all the eggs to 89; further, in the last lot of eggs so hatched, of which 37 per cent. were infertile, he lost not a single chick up to 4 weeks. It would seem that he has laid his finger on the missing link in the chain of successful artificial incubation.

Effect of Meteorological Conditions on Egg-Laying. *Laplaud, M., and Garnier, A., Revue de zootechnie, revue des éleveurs, Year 3, No. 8. Paris,* 1924. —The author takes as the source of his information the carefully registered results of the second and third National Egg-laying Competitions of Vaulx-de-Cernay. The meteorological data were collected at the same time by the Meteorological Station of the Competition and by another Meteorological Station of the domain of Vauls-de-Cernay.

Results obtained in the seasonal study.—In winter few eggs are laid, and the output of eggs depends upon a limited number of birds whose high egg-laying capacity renders them insensible to variations of temperature.

Very great changes of the barometer frequently correspond to sudden rises and falls in the egg-curve. Egg-production is distinctly decreased by the first cold, though a series of days with low temperature has little effect, but abrupt changes from day to day are marked by the variation curve. Hens readily adapt themselves to any given temperature, but they cannot stand changes in the temperature.

Wind without rain has little effect, unless the temperature changes suddenly; if the rain is warm, the wind promotes egg-production, but if the wind is accompanied by a cold rain the effect is most injurious. Windless rain influences egg-laying only in so far as it reacts upon the temperature.

In spring, egg-production increases in spite of great daily variations in the thermometer. The egg-production curve often follows barometric pressure for a short time. Very high or very low pressure often decreases egg-laying, the effect showing itself on the day or the evening of the maximum or minimum pressure.

Egg-laying is not arrested by a low temperature that falls progressively. The first warm days are favourable, but the first hot windless days reduce the number of eggs.

A hot or warm wind unaccompanied by rain is favourable to egg-laying, and a warm wind coupled with rain regularly increases the output of eggs, which is however checked by a cold wind accompanied by rain.

In summer, egg-production is high at the beginning, but flags during the intense heat, and rises again in the autumn. All extremes of barometric pressure have a bad effect upon laying hens. Temperatures varying between 10°C. and 15°C. seem the best. Great heat and sudden cooling off of the atmosphere both cause a fall in egg-laying. Winds in summer, even if they are stormy, have little effect. Rain, whether violent or not, is injurious on the day of its fall, but improves egg-laying during the following 2 or 3 days. Continuous rain for 2 or 3 days decreases the number of eggs, which however rises when the weather is fine again.

As regards the autumn, the time when the egg-laying competition finished, no exact data exist.

New and Effective Method of Freeing Animals from Ticks. *Di Sangiustino, I, La Nuova Veterinaria, Year II., No. 7. Bologna,* 1924.—The author describes a simple, cheap and speedy method adopted by the Arabs to free an animal from ticks instead of having recourse to the lengthy process of removing the pests one by one. For five consecutive days the Arabs give the tick-infested cattle pills made of barley pounded in a mortar, kitchen salt being added in the proportion of 200 gm. per 2 kg. barley. The animals readily take the salted barley. In the treatment for adult cattle 1 kg. (200 gm. per day) is necessary, while 500 gm. (100 gm. per day) are enough for calves. From the first day, the dead or dying ticks begin to fall out, and on the fifth day the animals are quite free from the parasites. The sodium chloride is directly absorbed and passes into the blood, of which the salt content rises progressively as is shown by the following instances:—

1st animal—sodium chloride reaction of blood = 6·380; after taking 150 gm. sodium chloride, reaction = 6·728.

2nd animal—reaction = 5·467: after 8 days' treatment, 6·844.

The explanation of the treatment is that the ticks are poisoned by the salt contained in the blood they suck from their host. This method has proved equally effective in the case of horses, but in order to administer sufficient salt to kill the ticks, it is necessary to introduce an œsophagean tube into the nostrils of the horse.

Danish National Service for Land Improvement. — The importance during the war of increasing wheat production led to the foundation in 1918 of a national agricultural institute for research, with reference to the improvement of unfertile land, especially as regards drought and liming. In addition it was proposed to undertake practical scientific investigation on hydraulics, etc. The National Service for Land Improvement (*Statens Grundforbedringsvæesen*) was directed by the governing body, under the control of Claudi Westh, who, under the title of *Norders Grundforbedrinc* (Land Improvement), has published a series of articles on work already accomplished.

The two outstanding subjects for investigation were drought and liming problems, but general cultivation was also considered. Research was carried out where agricultural organisations and private bodies had expressed the wish to collaborate with the National Service. About 10,000 military maps were elaborated for this work and contours drawn to show levels and divisions of territory.

Soil investigations have been confined to surface layers. Lime requirements are tested *in situ*, and observations made on local vegetation, plant diseases, etc., and, where necessary, soil samples have been taken from every 3-5 hectares for chemical and biological analyses. The results were recorded on maps, with accompanying explanations, and these maps were sent to the head of each defined area. The average moisture conditions were determined in the spring and the results recorded.

A scheme of improvement has been projected with reference to drought. In April 1922, about 184,000 hectares were investigated and 288,000 ha were registered for investigation, which constitutes more than 10 per cent. of the total arable land and meadows of Denmark.

It has been estimated that about 35,800 hectares of the land suffered from excess moisture. Calculations as to lime requirements were made from 42,700 fields, and it was found that about 23,900, *i.e.*, 57 per cent., needed lime

The publications issued by the National Service for Land Improvement amount to about 1000 pages and include numerous maps. The value from the economic standpoint of this work is evident.

Metric System in the United States. *Science, Vol. LIX., No.* 1537. *June*, 1924.—Prof. A. B. Beaumont has made a suggestion in favour of the extension of the metric system in the United States, namely, that the agricultural experiment stations plot their experimental fields in metres. The transition is easy and involves no expense, since the metre is of the same order as the yard and as yields in kilograms per hectare correspond approximately to pounds per acre.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in December 1924 and January and February 1925.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	December.			January.			February.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK:—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	73 5	65 8	47 10	71 1	65 1	46 9	68 9	62 4	46 0
Cross-bred (Shorthorn)	67 7	61 2	41 7	66 1	59 7	42 11	64 4	58 1	42 1
Galloway	63 11	57 8	...	62 7	57 6	.	62 2	56 9	..
Ayrshire	63 7	52 10	41 9	63 0	51 6	39 6	61 0	50 0	37 6
Blue Grey	.	..	...	60 6	...	...	.	..	..
Highland	69 4	63 11	55 0	...		...	..		..
	per lb. d.	per lb d.	per lb. d.	per lb. d.	per lb. d.	per lb. d	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES . .	18½	7¼	6½	18¼	7¾	6¾	17½	10¼	7
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot	17½	16½	12¾	18	17	13	18	16½	14
Half-bred . ..	18	16¾	11¾	18	17	11¾	18	17	12½
Blackface	17¾	16½	12½	17¾	16¾	12½	17½	16¼	13
Greyface	18	16¼	9½	18¼	17	9¼	18	16¾	10¾
Down Cross	17½	16¾	...	18	17¼	...	18	17¼	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d	per stone s. d.
Bacon Pigs	12 2	10 8	...	12 6	11 5	8 0	12 10	11 8	.
Porkers	12 6	11 2	...	12 9	11 9	..	13 1	12 1	..

Average Prices of Live Stock in Scotland—*continued.*

Description.	December.			January.			February.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
STORE STOCK:—									
Store Cattle—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head	Per head.	Per head
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	17 15	14 16	...	16 6	13 15	...	18 15	15 10	13 2
Two-year-olds ...	27 3	19 16	..	28 11	19 10	..	27 18	19 15	...
Cross-bred (Shorthorn):									
Yearlings	16 9	13 17	12 10	17 5	14 1	11 2	18 7	14 13	11 17
Two-year-olds ...	24 5	18 19	16 10	25 3	19 4	18 14	25 16	18 19	18 0
Galloway:									
Yearlings	16 0	...	...	15 0	12 10	...	17 5	.	
Two-year-olds	.	22 5			21 10	.	.	21 0	...
Ayrshire:									
Yearlings	...	..	.	...	..	.	..	..	
Two-year-olds ...	...	.			...	.	..	..	..
Blue Grey:									
Yearlings	..	..		..		..	.	.	.
Two-year-olds . .	.	20 10		..	.			...	..
Highland:									
Yearlings	12 5	9 8	...	.	...		.		..
Two-year-olds ...	15 10	13 13	...	...	.	...		.	..
Three-year-olds ...	...	18 0	15 0	...	..	.	...	..	
Dairy Cows—									
Ayrshire:									
In Milk ..	35 15	26 2	14 13	34 15	24 4	13 4	33 1	24 6	14 6
Calvers	35 18	26 3	16 10	35 14	24 16	15 13	33 9	24 6	15 5
Shorthorn Crosses:									
In Milk ...	40 13	30 1	21 3	38 2	28 13	21 8	38 9	28 11	20 11
Calvers	40 3	30 7	20 12	37 19	28 17	20 7	36 6	27 11	18 12
Store Sheep—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	...	...	30 0	77 10	...	...	58 0	46 0	36 0
Half-bred Hoggs	70 0	55 3	.	78 3	62 0	50 3	82 5	61 5	...
Blackface Hoggs ...	...	...	..	37 7	31 0	27 6	39 8	30 8	23 6
Greyface Hoggs .	...	43 3	...	61 1	50 6	43 0	62 11	50 10	40 7
Down Cross Hoggs	...	63 9	.	72 9	62 0	...	..	64 5	..
Store Pigs—									
(6 to 10 weeks old)	25 8	16 10	...	27 6	17 8	...	28 9	18 1	...

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Description	Quality.	December. Dundee	December. Edinburgh.	December. Glasgow.	January. Dundee.	January. Edinburgh	January. Glasgow.	February. Dundee	February. Edinburgh.	February. Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF:—										
Home-fed—										
Bullock or Heifer	1	10¼	10¼	12	10⅜	10⅝	11¾	9¾	10¼	11½
	2	9⅞	9⅛	10½	9¾	9½	10⅝	9½	9⅜	10½
Bull .	1	8¾	8½	8⅜	8⅞	9	8¾	8⅞	7¾	8⅝
	2	8	7⅞	7¾	8	8⅛	7¾	8⅜	7⅛	7¾
Cow ...	1	7	6⅞	7¾	7⅛	7¼	8	7⅜	7⅜	8¼
	2	6¼	6¼	6⅜	6¼	6½	6⅝	6½	6⅝	6⅝
Irish—										
Bullock or Heifer	1	9		9⅞	.	.	10¼	..		10⅛
	2	8¾		8¾		..	9⅛	..		9¼
Bull ..	1	..		8⅛		...	8⅛			7⅞
	2	..		6⅞	.		6⅞	..		6¾
United States & Canadian—										
Killed at Birkenhead	1		.	10½	.		10¼			..
	2		.	10	.		9⅞			
,, Glasgow	1			9¾	.		10¼	.		10
	2			8⅞			9¾			9½
Argentine Frozen—										
Hind Quarters	1		6⅛	..	.	6½	..	.	6½	
	2			.	.			.	...	...
Fore ,,	1		5⅛	..		5¼	..		5⅜	
	2			..			.			.
Argentine Chilled—										
Hind Quarters	1		7½	7⅝		7⅞	8		7¾	8
	2			7⅛		.	7⅝		7½	7½
Fore ,, .	1		5⅛	5¼		5½	5⅜		5¼	5½
	2		.	.			5⅛		5½	5¼
Australian Frozen—										
Hind Quarters	1		..	6¼	.			.	.	..
	2		.	5¾			...		..	...
Fore ,, .	1			...	.					...
	2	..	.	.			.			
MUTTON:—										
Hoggs, Blackface	under 60 lb	16⅜	13⅞	15⅛	16¾	13½	15⅜	15¾	13½	15⅛
	60 lb. & over	15	13	14⅜	16	13	14⅜	15	12⅞	14⅝
,, Cross ...	under 60 lb	16⅜	14½	15¼	16¾	14⅛	15⅜	15¾	14½	15⅛
	60 lb. & over	15	13⅜	14⅜	16	13¼	14⅜	15	13½	14⅝
Ewes, Cheviot .	1	10¾	9½	10½	11	10	11	11½	10½	12
	2	10¼		9⅜	10⅛	.	10	10¾	...	11¼
,, Blackface	1	10⅜	8¼	10⅛	11	.	10⅞	11½	.	12
	2	10¼	...	8½	10⅛	...	9	10¾	..	10¾
,, Cross .. .	1	8⅜	8½	8½	9	9⅛	9⅜	9	10	10⅛
	2	...	...	7⅞	8	.	8¾	8	..	9¾
Argentine Frozen ...	1	...	8⅝	8½	...	9	8¾	...		8½
	2		...	7⅞	...	..	8	..	...	7⅞
Australian ,, ..	1		...	...	..	9¼	..	..	8⅜	
	2	.	...	.	...	9	...	..	8¼	...
LAMB:—										
Home-fed	1	...	14¼	15⅜	...	...	...	...	...	...
	2	..	13½	15	...	...	...	...	...	...
New Zealand Frozen ...	1	...	13⅜	...	...	13⅜	...	...	...	..
	2	...	...	...	...	...	..	...	..	...
Australian Frozen ...	1	..	...	...	...	13	...	...	12¾	...
	2	...	...	...	..	...	...	...	...	..
Argentine ,, ..	1	...	...	...	...	..	8¾	...	...	...
	2	...	...	...	...	...	8	...	...	...

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	December. s.	December. d.	January. s.	January. d.	February. s.	February. d.
BUTTER :							
Argentine (Unsalted) per cwt.	1	207	7	177	0	175	6
Australian ... ... ,,	1	200	10	172	6	167	6
,, (Unsalted) ..	1	205	6	177	0	174	0
Canadian ... ... ,,	1	199	0	...		...	
Danish ... ... ,,	1	242	5	211	3	227	0
,, (Unsalted) ... ,,	1	248	2	217	3	233	0
New Zealand ... ... ,,	1	214	2	177	0	174	9
,, (Unsalted) ,,	1	218	9	182	3	181	9
CHEESE :							
Cheddar ... ... ,,	1	114	5	117	6	118	0
	2	110	0	111	6	112	0
Cheddar Loaf ... ... ,,	1	...		141	6	142	0
Dunlop ... ... ,,	1	106	5	115	6	116	0
	2	100	0	111	6	112	0
Canadian ... ... ,,	1	101	5	104	0	105	3
New Zealand (Coloured) ,,	1	101	5	103	0	103	0
,, (White) ,,	1	101	5	103	0	103	0
BACON :							
Ayrshire (Rolled) ... ,,	1	146	10	152	9	146	0
Irish (Green) ... ... ,,	1	136	0	141	6	143	0
,, (Dried or Smoked) ,,	1	134	0	151	6	153	0
,, (Long Clear) ... ,,	1	134	5	155	6	155	6
Wiltshire (Green) ... ,,	1	120	0	131	6	136	0
,, (Dried or Smoked) ,,	1	134	0	146	0	148	0
American, Long Clear Middles (Green) ,,	1	108	7	104	6	95	6
American, Short Clear Backs ... ,,	1	113	0	106	0	99	0
American, Sides ... ,,	1	100	10	97	0	88	0
,, Cumberland Cut ,,	1	100	10	90	4	86	6
Canadian, Sides ... ,,	1	108	2	102	3	95	3
,, Cumberland Cut ,,	1	101	4	94	0	90	6
Danish, Sides ... ... ,,	1	118	0	120	6	118	0

Description.	Quality.	December. s.	December. d.	January. s.	January. d.	February. s.	February. d.
HAMS :							
Irish (Smoked) per cwt.	1	180	0	176	0	212	0
	2	...		161	0	197	6
American, Long Cut (Green) ... ... ,,	1	118	10	109	6	104	9
	2	114	10	...		...	
American, Short Cut ..	1	110	10	116	6	103	3
	2	103	2	104	0	...	
Canadian, Long Cut ,,	1	118	10	112	6	101	0
EGGS :							
Country ... per doz.	1	3	4	3	2	2	8
	2	3	2	3	0	2	6
Irish ... ... per 120	1	27	7	25	3	19	11
	2	26	6	24	0	18	6
,, (Stored) .. ,,	1	20	0	19	0	13	9
	2	19	3	18	6	...	
,, (Duck) ... ,,	1	24	8	23	6	21	3
	2	...		22	6	20	0
American .. ,,	1	19	0	19	0	13	6
Argentine ... ,,	1	19	4	19	5	13	8
	2	18	4	18	0	...	
Canadian .. ,,	1	21	1	18	8	14	8
	2	20	1	...		...	
Chinese .. ... ,,	1	16	0	15	11	13	2
	2	15	11	15	6	11	8
,, (Duck) ,,	1	...		16	8	16	0
Danish ... ... ,,	1	27	8	26	2	21	0
	2	25	8	23	2	18	10
Dutch .. ... ,,	1	24	4	23	0	17	11
	2	...		19	6	...	
,, (Pickled) ,,	1	...		12	10	11	8
,, (Duck) ... ,,	1	19	9	...		19	7
Egyptian ... ,,	1	12	8	10	10	9	9
	2	11	9	9	10	8	11
Moroccan ... ,,	1	...		14	5	12	2
Russian ... ,,	1	18	11	17	8	...	
	2	18	2	...		...	

Average Prices of Potatoes at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Market.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Langworthy and Golden Wonder	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Langworthy and Golden Wonder.	Late Varieties. Other Soils. Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton £ s. d.
DECEMBER.							
Dundee ...	1	...	...	...	...	...	9 0 0
	2	...	...	...	...	...	8 10 0
Edinburgh ..	1	...	...	...	...	12 16 0	8 16 0
	2	...	...	...	...	...	...
Glasgow ...	1	...	...	14 13 0	11 16 0	13 7 0	9 17 0*
	1	...	...	...	...	...	8 14 0†
JANUARY.							
Dundee ...	1	...	...	...	...	...	9 0 0
	2	...	...	..	...	...	...
Edinburgh ..	1	...	...	...	...	12 15 0	9 5 0
	2	...	...	...	...	...	...
Glasgow ...	1	...	...	14 10 0	10 15 0	13 2 0	9 18 0*
	1	...	...	...	...	...	9 4 0†
FEBRUARY.							
Dundee ...	1	...	...	...	...	...	8 8 0
	2	...	...	...	...	...	...
Edinburgh ...	1	...	...	...	...	...	9 0 0
	2	...	...	...	...	...	...
Glasgow ...	1	...	...	14 8 0	10 10 0	12 17 0	9 17 0*
	1	...	...	...	...	...	8 18 0†

* Kerr's Pink. † Arran Chief.

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

MARKET.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley	Straw. Oat.	Moss Litter.
		per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton s. d.	per ton s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.
DECEMBER.										
† Dundee ...	1	...	24 0	31 6	116 0	...	84 6	84 6	88 6	49 5*
	1	...	...	...	105 6‡	...	...	...	...	...
‡ Edinburgh	1	...	...	...	105 0	...	65 0	55 0	62 6	45 0**
	1	...	...	..	...	...	...	...	...	40 0§
‖ Glasgow ...	1	...		.	91 0	100 0	60 7	...	59 0	37 6
	2	...	...	. .	...	...	...	...	...	...
JANUARY										
† Dundee ...	1	...	22 6	27 2	120 0	...	82 6	82 6	85 0	50 0*
	1	...	...		110 0‡	...	...	...	...	...
‡ Edinburgh	1	...	...	...	112 6	...	65 0	60 0	65 0	45 0**
	1	...	.	...	...	...	...	...	...	40 0§
‖ Glasgow ...	1	...	. .	...	95 0	100 0	55 0	...	55 0	37 6
	2	...	...	...	...	...	...	...	...	...
FEBRUARY.										
† Dundee ...	1	...	22 5	26 9	120 0	...	76 3	76 3	81 3	51 0*
	1	...	...	...	108 2‡	...	...	...	...	...
‡ Edinburgh	1	...	...	...	113 9	...	62 6	58 9	65 0	45 0**
	1	...	...	...	...	...	...	...	...	40 0§
‖ Glasgow ...	1	...	...	...	92 6	97 6	55 0	...	52 6	37 6
	2	...	...	...	...	...	...	...	...	...

† Quotations for Hay and Straw, baled and delivered.
‡ " " " delivered loose in town.
‖ " baled Hay and Straw, f.o.r.

* At Quay.
** Dutch.
§ Home.

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	December.		January.		February.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home ...	13 15 0	13 12 0	13 10 0	13 7 6	13 17 6	13 5 0
Foreign .	13 10 6		13 5 0	.	13 11 3	...
Decorticated Cotton Cake ..	14 0 0	...	13 10 0	...	13 13 9	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)...	8 18 0	8 10 0	8 11 3	8 1 3	8 5 0	7 13 9
Egyptian (Home-manufactured)...	9 7 0	.	9 2 6	..	9 0 0	..
Coconut Cake ...	.	.	13 0 0		12 12 6	.
Groundnut Cake— Undecorticated	*11 0 0	†10 15 0	*11 2 6	†10 15 0	*11 2 6	...
	**11 10 0	..	**11 12 6		**11 12 6	.
Maize Germ Cake—						
Home	12 10 0	.	12 11 3	...	12 13 9	...
Foreign .	12 0 0	.	12 10 0	.	12 15 0	...
Maize Germ Cake Meal	13 5 0		..	..	13 15 0	
Bean Meal ...	‖12 9 0	‖12 12 0	‖12 13 9	‖12 10 0	‖12 15 0	‖12 10 0
Maize Meal .	11 18 6	12 2 0	12 6 11	12 0 0	12 5 0	12 0 0
Locust Bean Meal...	.	8 17 0	..	9 0 0	10 12 6	9 0 0
Locust Beans (Kibbled and Stoned)		8 2 0	.	8 5 0		8 5 0
Maize Gluten Feed (Paisley) .	10 12 6	...	11 0 0		10 11 3	
Maize	§11 2 6	11 2 0	§11 10 0	11 2 6	§11 11 3	11 3 9
	‡11 8 4	.	‡11 12 6	...	‡11 14 5	.
Oats, Canadian (No 2 Feeds)	10 18 9	.	11 3 9		11 3 9	
,, Plate .	11 0 0		10 16 3	.	10 19 5	..
,, Home (New)	10 8 0	11 0 0	10 11 3	10 5 0	10 3 9	10 5 0
,, ,, (Old)	12 6 0	.	12 16 3	.	13 0 0	...
Barley (Feeding) ...	11 17 6	12 10 0		12 10 0	12 18 9	12 10 0
Barley Bran ...	11 6 8		11 5 0		10 15 0	...
Malt Culms. ...	9 0 0	.	9 0 0	..	9 0 0	...
Distillery Mixed Grains—Dried	10 0 0	10 0 0	10 0 0	10 0 0	10 0 8	10 0 0
Distillery Malt Grains—Dried .	10 1 3	...	10 3 9	...	10 0 0	...
Brewers' Grains—Dried .	.	9 0 0		9 0 0	.	9 0 0
Wheat—						
Middlings (Fine Thirds or Parings)	11 10 0	11 4 0	11 6 11	11 0 0	11 5 8	10 17 6
Sharps (Common Thirds)	9 1 6	9 6 0	9 9 5	9 0 0	9 10 0	8 18 9
Bran (Medium) ...	8 16 6	8 8 0	9 10 0	9 1 3	9 10 0	9 5 0
,, (Broad) .	9 1 6	8 18 0	9 15 8	9 15 0	9 15 0	9 15 0
Feeding Treacle	9 2 6	9 5 0	9 7 6	9 5 0	9 5 0	9 5 0
Fish Meal	.	19 0 0	...	19 0 0	...	19 0 0
Beans—English ..	13 11 3	.	13 15 0	...	13 15 0	...
China .	11 5 0	...	11 13 9	...	11 11 11	...
Morocco ...	12 0 0	...	12 3 9	...	12 5 0	...
Pease—Calcutta White	12 6 5	..	12 7 6	.	..	...
Grain—Karachi Red	11 3 9	...	11 5 0	...	11 3 9	..

* 37 per cent. Oil and Albuminoids.
† 8 per cent. Oil and 31 per cent. Albuminoids.
§ Plate.
** 40 per cent Oil and Albuminoids.
‖ Pure China Beans.
‡ South African (Yellow).

Printed under the authority of HIS MAJESTY'S STATIONERY OFFICE
By J. Skinner & Co., Ltd., Thistle Street, Edinburgh.
(4984.) Wt. 10321/179. 1625. 4.25. J.S.&Co.,Ltd. G. 19.

The Scottish Journal of Agriculture.

VOL. VIII.—NO. 3.] JULY 1925. PRICE 1s. NET.

THE SCOTTISH CONFERENCE ON AGRICULTURAL POLICY.

A PUBLICATION of great interest to all who are concerned with agriculture and rural life in Scotland is the Report of the Scottish Conference on Agricultural Policy, which was recently presented to the Secretary for Scotland and has now been issued by H.M. Stationery Office. The Conference, which was convened by the Secretary for Scotland in March last, and which consisted of persons representative of various agricultural interests, was asked "to consider what measures, if any, are necessary either by the State or by the agricultural industry itself or by both in concert (1) to maintain and (2) to increase the area of arable land in Scotland, and by what further measures the economic maximum production of food from all the agricultural land of the country can be stimulated."

The interests represented and the members of the Conference were as follows :—

Land Owners :—

His Grace the Duke of Buccleuch, K.T.
Sir Kenneth Mackenzie, Bart.
Sir John Stirling Maxwell, Bart.
Sir David Wilson, Bart., D.Sc.
Mr. G. Erskine Jackson, O.B.E., M.C.
Major Keith.

Tenant Farmers :—

Mr. Harry Armour.
Mr. James Elder.
Mr. A. Forbes.
Mr. John M'Caig.
Mr. A. W. Montgomerie.
Mr. James Paton.

Small Holders :—

Mr. James Ellis.
Mr. John Miller.

Farm Workers:—

Mr. A. Blyth.
Mr. T. Dougan.
Mr. George M'Combie.
Mr. T. Scott.
Mr. R. Steel.
Mr. R. Wann.

Agricultural Co-Operation:—

Major Mark Sprot.

The Conference appointed one of their number, Mr. James Elder, Athelstaneford Mains, Drem, as Chairman and Mr. J. M. Caie as Secretary.

As indicated in their terms of reference and also in the address delivered at the opening meeting by Sir John Gilmour, the main purpose of the Conference was "to propose various practical measures, capable of early adoption, which would lead to greater agricultural prosperity, with all the important effects that would follow therefrom." With this object in view the Report deals with many subjects of agricultural importance, and contains a large number of detailed recommendations designed to place the industry in a firmer economic position and to improve the conditions of rural life in general.

In formulating their various proposals, the Conference have taken as their guiding principle the view that agriculture, as compared with other industries, "is of peculiar importance to the social and economic life of the nation, and that its welfare should be one of the especial cares of the State." It is on this basis that claims are advanced for certain measures of aid or relief by the State. The Report, which is unanimous and without any dissentient note or reservation, states that, notwithstanding the variety of interests represented, the deliberations of the Conference were completely harmonious from beginning to end, a fact which, they hope, will be of some value in commending their views to the Government and to the country.

At the outset, the Conference record their opinion that without some such measures as tariffs on imports, subsidies or regulation of prices in the home markets, there can be no large increase in the area of arable land in Scotland. They do not, however, consider that a general policy formulated on these lines would find acceptance, and they therefore fall back on "less heroic" proposals. It is believed, nevertheless, that the cumulative effect of these would be "to help in maintaining the arable area, to lead to a better average standard of farming, and to secure a larger rural population."

Foremost amongst the subjects referred to in the Report is that of Land Drainage, as the improvement of which a large proportion of the agricultural land in Scotland stands most in need at the present day. The beneficial effects of what has been done during the last four years under the scheme for the relief of unemployment are recognised, but it is urged that the restrictions hitherto imposed should be removed, and that the work should be carried on as

one of agricultural improvement and not as one of unemployment relief. Recommendations for the provision of State assistance on this basis are submitted. Prominence is also given to steps proposed for securing adequate and readily accessible supplies of lime for agricultural purposes.

Farm buildings and equipment and rural housing are next considered. With regard to the latter, it is pointed out that existing legislation has done little to aid in the erection of houses in rural areas and particularly of houses for farm workers. Comprehensive and detailed proposals are made both for the building of new houses and for the improvement of existing houses.

Great stress is laid on the importance of education and research to agriculture and to rural economy in general. The Conference say, "In our view the future prosperity of the industry will depend in great measure on the further extension of technical education, and on the carrying out of scientific investigation likely to lead to results capable of practical application." Subject to one or two qualifications, the Report endorses the recommendations of the Committee on Agricultural Education which was presided over by Lord Constable, and which reported last year. Special reference, however, is made to the need for more generous treatment of the Research Institutions; to the importance of soil surveys and analyses; to the desirability of having a large number of small demonstration areas; and to the need for further investigation as to the best means of improving pastures, both on low ground and on hill land.

An important section of the Report deals with land tenure. The effect of the breaking up of the large estates is discussed. In answer to the important question of whether Scottish land tenure in future should be based mainly on the system of landlord and tenant or on that of occupying ownership, the Conference reply that, "given suitable conditions there is room for both systems in the country, and that indeed both should exist side by side." Following on this conclusion, the Report goes on to recommend measures to secure better maintenance of the larger estates, and also to safeguard agricultural interests in cases where a tenant is obliged either to purchase or to vacate his holding. Other subjects mentioned under land tenure are "led" farms or "out" farms, farm records and smallholdings. With reference to this last subject the Report says, "We are entirely sympathetic to the existence of smallholdings, but, having regard to our terms of reference, we are not prepared to advocate the further extension of land settlement until careful economic enquiry has been made into the results obtained on existing smallholdings." The Report, however, emphasises the importance of smallholdings as providing a "ladder" for the agricultural worker, and puts forward the suggestion that, where a holding is intended to provide full-time employment for the holder, it should be of about 50 acres of good arable land or up to 100 acres in the case of inferior land.

Taxation and Rating are considered in some detail. In approaching the subject the Conference say, "We are impressed by the fact that the existing burdens on agricultural land constitute in effect a heavy tax on home grown food. This fundamental

point is often overlooked. Whilst there is a widespread demand throughout the country that the food of the people should not be taxed, enormous burdens, both Imperial and local, are placed on the producers of food at home, burdens from which the foreign producer is exempt." It is with a view to alleviating the situation referred to in this preliminary statement that certain proposals are made for affording relief from part of the burden of rates and taxes which agricultural land at present bears.

Amongst the other sections of the Report may be mentioned the following:—Electrical Supply; Telephones and Transport; Importation of Agricultural Produce; Improvement of Live Stock; Dairying; Eradication of Bovine Tuberculosis; Organisation; Marketing; Allotments, etc.

With regard to the Importation of Agricultural Produce, the Report recommends legislation on the lines of the Merchandise Marks (Agricultural Produce) Bill, 1924.

On the subject of the Improvement of Live Stock the Conference do not suggest any material alteration in the schemes administered by the Board of Agriculture, but with regard to the improvement of cattle-breeding they suggest that in order to effect the gradual elimination of the "scrub" bull, the Board's scheme should be made applicable to farms of all sizes and should not be restricted as at present to those not exceeding 100 acres in extent or £100 in rental.

A very interesting section is that relating to the Eradication of Bovine Tuberculosis. In considering the subject the Conference have kept in mind not only agricultural interests, but the great importance of the question from the point of view of national health. The promised introduction of a measure on the lines of the Tuberculosis Order of 1914 is welcomed, and the Report goes on to formulate a full and detailed scheme for adoption by farmers, which it is believed would secure the complete eradication of bovine tuberculosis from Scottish herds. While some slight assistance would be required in carrying through the scheme, it is one the operation of which would depend almost entirely on the farmers themselves.

As will be seen from the foregoing brief outline, the Report touches agriculture and rural life at many points. Its discussion of the various subjects with which it deals constitutes a condensed survey of rural conditions as they exist in Scotland at the present day, while its recommendations combine to form a constructive policy which, if adopted, could not fail to have far-reaching effects. The Report will doubtless be widely read by all sections of the community who are concerned with the prosperity of agriculture and the welfare of our rural population.

Copies of the Report may be obtained through any bookseller or directly from H.M. Stationery Office, 120 George Street, Edinburgh, price 1*s*. 6*d*.

BOVINE TUBERCULOSIS.

With especial reference to eradication measures.

Professor S. H. GAIGER, F.R.C.V.S.

THE prominence given of late in the press to a preventive vaccine against tuberculosis discovered by MM. Calmette and Guérin of the Pasteur Institutes of Paris and Lille, makes it worth while to survey our position in regard to this disease in order to see how we stand, and whether we are accomplishing anything towards eradication.

It is safe to say that were bovine tuberculosis a disease of more spectacular symptoms, like foot and mouth disease, and were its onset more rapid and its losses more quickly evident, measures against it would long ago have been more drastic, and the country would at the present time have made better progress towards that desirable achievement, eradication.

The need for eradication.—The problem is at the same time an economic, an agricultural, and a public health problem. It is the public health aspect of the disease that provides the stimulus for public interest in it. Without this, the general public would take no more interest in this disease than they do in say stomach worm or liver fluke infections in sheep, which are the economic concern of agriculture only.

As an economic problem for agriculture, bovine tuberculosis is a serious matter. The loss in actual deaths may not be very noticeable, but affected animals fall away in condition and require more food to keep them going and to fatten them. The amount of milk they give is lessened. Their calves which are born free of the disease (except less than 1 per cent. born tuberculous) do not long remain uninfected and do not thrive as they would if they remained healthy. The carcase of infected animals may be partly or wholly unfit to be passed for human consumption. The disease in cattle is a fruitful source of tuberculosis in pigs, of which 10 per cent. are believed to be tuberculous in Britain.

In Britain, Delépine found that in bovines under one year old 3·4 per cent. reacted to tuberculin, in those from 1 to 2 years 13·2 per cent. reacted, from 2 to 3 years 23·5 per cent., and from 5 to 9 years 48·9 per cent. Parker at Newcastle recently examined 121 cows brought from various dairies for slaughter and found 77·68 per cent. affected on postmortem examination.

In France in 1903 Nocard and Leclainche estimated that 10 per cent. of all cattle were tuberculous. Soon after this Guérin estimated 16·5 per cent. to be tuberculous. Recent estimates of infection in housed dairy cows show over 40 per cent. infected, and in cows kept at pasture most of the year from 16 to 30 per cent. From available official figures Calmette estimated that 2 millions out of 13 millions of bovines in France are tuberculous, but Sausseau thinks this is a gross over-estimate, for reasons which he points out.

In the United States it has been found that in some States from 5 to 30 per cent. of all cattle are infected, whereas in other

States less than 1 per cent. are tuberculous. About three-fourths of the dairy cows have been found infected in some places.

The loss from bovine tuberculosis is enormous in the aggregate. It has been estimated for Britain at one million pounds annually, for France over three quarters of a million, and for the United States over one and a half millions.

At first sight the above figures are depressing and eradication would seem to be a hopeless task. It must be borne in mind, however, that all tuberculin-reacting animals are not in danger themselves or even dangerous to others, though all are potentially dangerous, particularly under the adverse conditions in which so many cows exist. The great majority of human beings after middle age have a tubercular lesion of some kind in the body. Further comfort may be derived from the fact that there are always some herds which have managed to remain tubercle-free, though these are fewer in number in countries where herds are large, where few herds are self-supporting, and where there is much movement of stock, as in Britain. In Sweden, Regner found 31 per cent. of herds free of tubercle M'Fadyean says it is certainly less than this in Britain, and that amongst Shorthorns, Ayrshires and Jerseys it is doubtful if 5 per cent. of herds are free. Bang, in Denmark, knew of 2203 free herds in 1900, containing 30,000 cows. In Norway, with a cattle population of only one million, where herds are small and self-supporting with only ten or twenty head in each, Malm found that under 10 per cent. and in some parts under 5 per cent. of cows are tuberculous.

As a public health problem, bovine tuberculosis takes on a still more serious aspect. It has now been abundantly proved that Koch was wrong in his contention, at the British Congress on Tuberculosis in 1901, that the bacillus of bovine tubercle could not infect human beings. This assertion from the discoverer of the tubercle bacillus was a serious set-back to the progress of measures against bovine tuberculosis. The disease according to his version had ceased to be a public health problem. Many scientists at the Congress dissented from Koch's view. A great stimulus was given to the study of human, bovine and avian tuberculosis. The result of this world-wide study has been to settle beyond question that a far from negligible proportion of cases of human tuberculosis and a considerable proportion of the cases occurring in children are caused by tubercle bacilli from a bovine source.

Griffith in Britain published in 1920 the percentages of human cases of tuberculosis in which the causal organism was shown to be of the bovine type. Up to that year 1068 cases had been examined with the following results:—

In tuberculous children up to 5 years old the bovine type was found in 37·5 per cent.

In those from 5 to 10 years old the bovine type was found in 29·4 per cent.

In those from 10 to 16 years old the bovine type was found in 14·6 per cent.

In tuberculous subjects over 16 years old the bovine type was found in 6·2 per cent.

The bovine type was found to be responsible for 85 per cent.

of gland tuberculosis cases in children under 5 years of age, and 18 per cent. in adults.

Mitchell in Edinburgh examined 72 cases of tubercular neck glands in children and found 88·6 per cent. were caused by the bovine bacillus.

In Mississippi (U.S.A.) it has been found that of abdominal cases of tuberculosis in human beings 58 per cent. are due to the bovine bacillus.

In Christiania, Malm states that 10 to 20 per cent. of cases of tuberculosis in children are due to the bovine organism.

In France, Calmette states that 4 to 10 per cent. of all tubercle cases in children are caused by the bovine type of bacillus, but that in adults only 3 cases per 1000 are due to it.

Many other observers have published the results of their investigations. All are in agreement that a large percentage of cases of tuberculosis in children is due to the bacillus derived from cattle. Presently it will be shown how easily the bovine and human types of tubercle bacillus can be distinguished from one another, so that there can be no reason for the layman to doubt the accuracy of the scientific observations recorded above. It has further been shown that the cases in children, in which the bovine bacillus has been found, are mainly cases of tubercular neck glands, tubercular bones and joints, and intestinal tuberculosis. The last mentioned causes death in children, the other two are responsible for disfigurements and cripples.

Few would be foolhardy enough at the present day to maintain that cattle affected with tuberculosis are not a source of danger to human beings and that precautions against infection can be ignored.

There is every justification for concluding that bovine tuberculosis is readily transmissible to man, and for further concluding that the usual method of transmission is by means of milk from tubercular cows given unsterilised to children under the age of sixteen. The question of the extent to which milk upon sale in this country contains tubercle bacilli will be dealt with presently.

The cause of tuberculosis.—The cause of this disease was shown by Koch in 1882 to be the bacillus of tuberculosis. It is therefore a bacterial contagious disease. The tubercle bacillus does not multiply outside the body, and therefore it follows that all new cases arise from coming into contact with affected animals or by means of indirect contact through animal products, as for instance milk, dung, etc. The bacillus may live several months outside the animal body if not exposed to sunlight, as for example in dry manure. It is quickly killed by direct sunlight, in less than one minute by 5 per cent. carbolic acid, at once by a temperature of 212° F. (boiling), and at 149° F. if kept at that temperature for 20 minutes. In the body the bacillus is almost confined to the actual places where signs of the disease are evident, that is to say in the so-called tubercles in the glands and the various organs, as the lungs, liver, spleen, kidneys, etc. Frequently it can be shown to be present in the blood by inoculating some blood into a guinea-pig, but usually its numbers in the blood are too small to permit of

its being found by the microscope. It is present in all discharges from tubercular lesions.

There are three distinct types of tubercle bacilli: (1) the human, (2) the bovine, and (3) the avian. The avian type is of interest as the cause of tuberculosis in poultry, and it has sometimes, though only rarely, been found causing serious symptoms in man, cattle, horses and pigs. It is with the bovine and human types that this article is more concerned. The bovine type is almost exclusively the type which one finds in cattle. The human type is that which is generally found in man. Each of these two types however is not confined to its own species, for we find the bovine type causing tuberculosis in swine and horses, and, as we have seen, occasionally in adult human beings, and frequently in children. The human type is also found in dogs, cats and pigs. In all three types, human, bovine and avian, intermediate forms have been encountered. There is some evidence that the bovine type may become converted into the human type, in man.

The distinctions between the human and bovine types are well-marked and unmistakable to research workers. The human bacillus grows more readily upon artificial culture media than the bovine. The bovine bacillus is much more deadly for all species of animals upon experimental inoculation. In artificial culture, glycerine favours the growth of the human type, but actually inhibits the growth of the bovine type. These distinctions are sufficient to determine to which type a tubercle bacillus, found in say tubercular neck glands, belongs.

Symptoms.—The symptoms of bovine tuberculosis are varied according to the organs in the body which are attacked. Affected animals may be in poor condition with an unthrifty appearance. If the lungs are affected the respirations are increased. There is often a chronic cough. Enlarged lymphatic glands in various parts of the body may be seen or felt. The affected udder and the lymphatic glands at its base become harder to the feel. Milk from an affected udder is at first normal in appearance, but later is much altered from the normal, being flaky or curdled. There is no characteristic symptom by which tuberculosis can with certainty be diagnosed. It must further be remembered that an animal may be extensively diseased and giving off tubercle bacilli in her milk, and yet be to all outward appearance in perfect condition and health.

Method of spread.—The tubercular bovine is of importance as a spreader of infection to other cows and to other species of animals and man just in so far as it gives off tubercle bacilli from its body.

The germs of the disease may be coughed up from the lungs and soil the fittings in the byre in front of the animal, but the greater number coughed up in discharges from the lungs are swallowed and pass out alive and virulent in the dung. The milk of all animals with tubercular udders contains them. They are present in the milk from animals showing definite symptoms of the disease. They may be present in the milk of a cow with an apparently healthy udder, but they are *not usually* present in the milk of a cow whose only sign of disease is a positive reaction to

the tuberculin test. Tubercle bacilli are found in the urine of animals with tubercular kidneys. They are present in the vaginal discharges of cows with tubercular wombs. They are present in the dung of all animals with tubercular lungs and with tubercular ulcers in the intestines. They are present in the discharges from any burst surface tubercular lesion.

Affected animals which are discharging tubercle bacilli from their bodies are often spoken of as cases of "open" tuberculosis. There is no means of saying whether or not many cases met with are "open" cases or not, other than by detailed laboratory tests. The ordinary clinical examination cannot as a rule settle the point. The so-called "closed" type is one which has a tubercular lesion locked up, or as it is termed encapsuled, in some organ of the body. Even if a tubercular cow is not giving off bacilli by any route from its body or is not for the time being a source of danger, one has to recognise that its "closed" lesions may, under adverse conditions, at any time become "open." Every tubercular animal is therefore, if not an actual, a potential spreader of tuberculosis.

It is well known that when a tubercular cow is introduced into a byre the cows which first become infected from her are her neighbours in the byre. Tuberculosis is a disease of co-habitation just as much as is the case in human beings. Its spread is facilitated by dark ill-ventilated byres, by the lowered vitality which arises from forced lactation, and in some cases by improper nutrition. Without doubt the nutrition of dairy cows would be a less expensive matter if there were no tuberculosis. As Bang has put it, "It does not pay to have to feed the tubercle bacillus as well as the cow." There can, however, be no tuberculosis without the presence of the tubercle bacillus, the actual causal bacterium.

As a public health matter one is concerned with the extent to which tubercle bacilli are present in cows' milk as sold to the consumer. They may get there from the infected cow direct. They may get into the milk of healthy cows by contamination of the milk in the pails by dung from diseased cows, and they may contaminate and render dangerous large quantities of tubercle-free milk by admixture with the milk of one tubercular cow containing tubercle bacilli. There may be many dairies where only one or two cows are giving milk containing tubercle bacilli, but nevertheless the milk of the whole dairy will be infective for children if the milk of the tubercular cows is mixed with it.

A considerable number of observations have been made of the extent to which tubercle bacilli can be found in milk intended for the consumer. During the short time the Tuberculosis Order of 1913 was in operation, 8073 cases were dealt with. Of these 6671 were in England and Wales and 1402 in Scotland. The whole 8073 were from almost the same number of farms. The cases which were compulsorily notifiable under the Order were, any cow with tubercular mastitis, indurated udder or chronic udder disease, any bovine with tubercular emaciation, and any bovine with chronic cough or clinical tuberculosis. It was found that in England, Wales and Scotland, 1450 premises were producing tubercular milk and 6500 premises were housing tubercular emaciated cattle. It is not to be supposed that in the first year of

working of the Order more than a part of the existent notifiable cases were actually notified.

In Birmingham over a period of 18 years it has been found that 8·7 per cent. of samples taken from churns contained tubercle bacilli. In Manchester 10 per cent. of samples have been found tuberculous.

Healthy animals become infected by taking in the tubercle bacilli in their food. Possibly a small proportion get infected by inhaling dust carrying the bacilli. The bacilli when taken into the stomach and intestines in the food may set up tubercular lesions in the bowel, causing ulcers there, or lesions in the neighbouring lymphatic glands. It is known, however, that ingested bacilli can pass on into the system without infecting the bowels, and can arrive by the blood stream at other organs such as the liver, lungs, kidneys, etc., where they start to grow and multiply. Calves become infected early in life by being given milk in the raw state from their tubercular mothers.

It is very unfortunate that while milk is the staple food for the young, calves and children alike, it is at the same time the best of food for encouraging the multiplication of bacteria which gain access to it.

Infection can be conveyed by contact with diseased animals at pasture and in sales, and by contaminated railway trucks.

Post-mortem Appearances.—In bovine tuberculosis the lesions may be present in any part of the body, as for example in the glands, lungs, liver, bowels, kidneys, womb, udder, bones, etc. They are hardly likely to be mistaken for any other disease when they are of a size to be readily seen by the naked eye. Yellowish white masses are found to have taken the place of the healthy tissue, and when cut through with a knife they are of a cheesy consistency, and very commonly contain limy deposits which make them gritty to the feel when being cut. Very young lesions, say those smaller in size than a hazel nut, are glistening and translucent in appearance after section with a knife. Whilst the lesions are as a rule unmistakable to the naked eye, they are characteristic of tuberculosis when examined under the microscope. Even if tubercle bacilli are not specially looked for, the microscopic cell structure of the lesion is proof positive of the disease. The demonstration of the tubercle bacillus in the lesion serves to confirm the diagnosis. The question of errors in diagnosis upon post-mortem examination does not arise.

Diagnosis.—The disease, as pointed out, has very often no characteristic symptom from which one can with certainty make a diagnosis by a simple clinical examination. There are, of course, well-marked cases with symptoms which leave little room for doubt that the animal is tubercular, but about the majority of cases a simple clinical examination carries one no further than being able to say "I should suspect that animal of being tubercular." Some of the latter cases may have the suspicion confirmed by finding the bacilli with the aid of the microscope, as for example in suspected tubercular mammitis. It is well, however, to point out here that while the bacilli may be present in the milk in sufficient numbers to infect animals experimentally inoculated

with it, they are often too few in numbers to be found in the small quantity examined by the microscope even when the centrifuge is used to aid in their concentration. It follows, therefore, that while the finding of tubercle bacilli in the milk by the microscope enables a positive diagnosis to be made, inability to find them by this means does not warrant one in making a negative diagnosis. One is only justified in the latter case in saying "bacilli are not present in that milk sample in sufficient numbers to be found by the microscope," which means very little. To be able to say with certainty that a milk sample is free from tubercle bacilli one must resort to guinea-pig inoculation, and one should effect a concentration of the bacilli by centrifugation of the sample. This is necessarily a laboratory method.

Examination of the dung of a suspected animal by the microscope is of little value as a means of diagnosis owing to the impossibility of distinguishing the tubercle bacillus in such material from other bacilli of similar appearance which may be present in it Here again guinea-pig inoculation has to be resorted to in order to demonstrate the bacillus, treating the dung sample with antiformin, which has the property of destroying other bacteria and leaving the tubercle bacillus alive, or one may feed the suspected dung to a healthy young pig and await infection. Such animal experiments have the disadvantage of being time-consuming in a matter where the saving of time in making a diagnosis is of importance.

Examination by the microscope of coughed up discharge from the respiratory apparatus can be used to confirm a diagnosis, but for obvious reasons with cattle this method has not the practical application it has in the human being. A method of taking throat swabs from cattle is in use in Sweden as a means of diagnosis.

Fortunately science has placed in our hands a means of diagnosis in the shape of the tuberculin test, which in competent hands has been found to be efficient in 98 per cent. of cases. Many years of experience have proved this test to be the most satisfactory and practical way of arriving at a diagnosis in the living animal.

Tuberculin consists of the poisonous products of the tubercle bacillus in solution. It contains no living bacteria, and is without ill-effect upon healthy animals even when many times the dose usually employed is given to them. In an animal affected with tuberculosis small quantities of tuberculin, manufactured by the living germ in the lesion where it is growing, get into the animal's system and render it sensitive to tuberculin—that is to say, make the animal liable to "react" if tuberculin be artificially injected into the system. This sensitiveness may be destroyed if the system is accustomed to larger quantities of tuberculin, as in the case of an animal far advanced in the disease. In such a case the infected animal's system is so saturated with tuberculin from the quantities received from the large numbers of bacilli in the body that it is no longer sensitive, and a "reaction" cannot be provoked artificially. This destruction of sensitiveness is made use of by unscrupulous persons to render an infected, but otherwise valuable,

animal insensitive to the tuberculin test and deceive the intending purchaser into thinking the animal healthy.

The method of the subcutaneous tuberculin test is now sufficiently well known to agriculturists not to need description in detail here. It has some limitations which it is well to recognise. Since the reading of the test is in accordance with the rise of temperature which takes place above the normal, it follows that animals with fever from any cause cannot be subjected to it. The test is uncertain in animals about to calve and in those which have just calved, and, as stated, in those far advanced in the disease. It cannot be relied upon to detect tuberculosis which is only in the incubative stage, that is to say, in animals where the bacilli have not multiplied in the body for a sufficiently long period after actual infection for the system to have become sensitive to tuberculin artificially injected. In cases far advanced in the disease there is no need of the tuberculin test for diagnosis. The other limitations mentioned can be set right by a test at a later date. One cannot, unfortunately, minimise the limitations put upon the test by the fraudulent use of tuberculin by unscrupulous persons. Unless the law can step in with heavy penalties for such fraud, or unless tuberculin is subjected to some form of control, the mischief will continue since human nature is not yet Utopian. One is given much food for thought when one sees rows of empty pint-bottles of tuberculin in a cupboard in a breeder's house, and still more on being told, "Yes, I test my cattle regularly and *never* get a reactor." Of course, it *may* be true that here there is no dishonesty, but it is equally true that in numbers of cases there certainly is. "This," in the words of Sir John M'Fadyean used in another connection, "involves no disparagement of the honesty of farmers and other owners of cows as a class, but simply recognises that they include the usual proportion of individuals liable to succumb to the temptation of breaking a law when compliance with it appears to run counter to their own interests." There is no "law" as yet with regard to tuberculin, and moral obligations are equally open to non-compliance. Veterinary practitioners might in many cases do something towards preventing the misuse of tuberculin by refusing test certificates to any breeder who makes use of tuberculin himself, but the former are in a somewhat difficult position in such a matter. It is not an easy matter for the fraudulent user of tuberculin to conceal his misdeeds. The information may not leak out in all cases so naïvely as in the case of the farm hand who informed the veterinary surgeon, when preparing to do some tests, that "I knew you were coming because the boss has been round with his syringe lately, getting them all ready for you," but still the information does reach the ears of the veterinary surgeon, and he is perhaps in the best position to know the extent of the malpractice.

The tuberculin test methods, other than the subcutaneous, are the intradermal used upon cattle at the base of the tail, and the ophthalmic. They serve as useful checks upon the subcutaneous method, the latter being seldom used except in conjunction with it, the intradermal test being sometimes used alone.

Tuberculin is a valuable discovery. Its use as a reliable diagnostic became almost a crusade in some countries in order to separate

healthy from diseased animals. It is not infallible, but in competent hands it comes as near to being infallible as anything mortal can be. As long as it is not subjected to any control, as long as it can be made by anyone in any strength, and as long as it can be purchased and used by anyone in any quantity, so long will its value be seriously detracted from. In the United States anti-tuberculosis campaign the Bureau of Animal Industry makes and supplies the tuberculin used.

Eradication. — It is useful to examine the possibilities in eradicating tuberculosis and see what measures have been put into practice in this and other countries.

We have seen that bovine tuberculosis is a widespread contagious disease, affecting a serious proportion of not only cattle and pigs but children, spreading amongst cattle like any other contagious disease by contact of healthy and affected. In order to get rid of the disease one must work along lines well recognised for the control of contagious diseases. One must be able to detect all affected animals, not only those which are obviously affected, but those infected which are in apparently perfect health and yet harbourers and may be carriers of the disease. One must have the means of separation of healthy and affected, with a view to isolation of the affected to render them harmless or slaughter with the same object, since one knows the tubercle germ only increases in numbers in the living body. One must be prepared to disinfect infected premises before housing healthy cattle in them. Alternatively one might look for some means of immunising healthy animals so that they can resist infection to which they are exposed, by which means in time the disease would die out for want of a suitable soil, in the shape of susceptible animals, in which to flourish. With means to detect and means to immunise, a combination of all the above operations would come into being against the disease.

In tuberculin we have the means of detection, and now, as a result of years of ceaseless labour, we seem to be in possession of a method of immunisation.

Britain introduced the Tuberculosis Order of 1913, replaced it by that of 1914, and discontinued this when war broke out. It has not since been re-introduced, but its re-introduction is promised this year. This Order prevented the sale of milk from cows with tubercular udders, or suffering from advanced tuberculosis. It provided for notification and slaughter in such cases and partial compensation to the owner for his loss. In one year of working over 8000 tuberculous animals were dealt with. The Milk (Special Designations) Orders, 1923, made under the Milk and Dairies (Amendment) Act, 1923, are partly aimed at lessening the danger from tuberculosis. All of the grades, Certified, Grade A (tuberculin tested), and Grade A provide for regular veterinary inspection, and the two first grades provide for tuberculin testing. All of the grades limit the number of Bacillus coli which may be present, this meaning that contamination of milk with dung must be reduced to almost *nil.* The B. coli provision is inserted only because this bacterium indicates fæcal contamination. Less fæcal contamination means fewer tubercle bacilli from that source.

The Graded Milk system is not compulsory, indeed compulsion could not have made it a success. Owners of dairies are free to adopt this system or leave it alone.

Since the Grading system can at present only be optional and the Tuberculosis Order is not in operation, it follows that very little is going on in Britain to further the cause of tuberculosis eradication. It is true that interest is being more and more aroused amongst farmers in the possibility of getting their herds tubercle-free, but in the majority of cases this simply means passing on the diseased animals to someone else. We are at present scarcely picking at the fringe of a great and serious problem.

Bang's system of building up tubercle-free herds, which will be referred to presently, has had a very limited application in Britain.

The United States of America are carrying on a vigorous campaign against the disease. The disease is dealt with (1) in pure-bred herds, (2) in circumscribed areas of the country, and (3) in swine. The whole method is based upon the tuberculin test, after which reactors are removed and premises disinfected. The herds are re-tested in six months and the same process carried through. The infected herd is not accredited (certificated) till it has successfully gone through two successive tests, the 1st successful test being six months after the removal of all reactors. The certificates given for accredited herds allow certain privileges regarding inter-State movement, the value of the herd is greatly increased, purchasers have increased confidence, and the milk commands a higher price. Certain restrictions are necessarily imposed to prevent the herd becoming re-infected, such as railing them only in specially disinfected trucks, association only with the cattle of other accredited herds, the calves only to be fed upon the milk of the accredited herd, and purchases only to be made from other accredited herds. Such certificates only hold good for twelve months, and re-testing is done annually. Certificates may be cancelled if owners do not comply with the letter and spirit of the rules. Cattle shown by the tests to be affected are branded, and may not be moved except for slaughter. Trucks conveying them are marked "Tuberculous cattle," and are specially disinfected. Compensation is paid for cattle slaughtered. Pigs may not be fed upon infected dairy products. The method has been found expensive. It is recognised that "it would not be possible at this stage to undertake to eradicate tuberculosis from the live stock of the United States solely through organised official sources established by the respective States and the Federal Government." "Every live stock owner should be a party to the campaign."

The United States in their campaign have found the need for competent veterinarians to do the tests, and the value of a reliable tuberculin. There are now records of many herds, in which three-fourths of the animals were affected with tuberculosis, which have become free and are maintained in a healthy state. Experience has shown the necessity for continued care and vigilance in order to maintain the herds healthy; for example, one herd had been free for a number of years when early in 1917 four cows were purchased without being properly tested. In December 1917 there

were five reactors, and in January 1919 amongst the 28 cattle there were eleven reactors and two suspects.

In Denmark, Bang introduced his system of eradication. This is based upon the well-known fact that calves even from tuberculous parents are born healthy (in less than 1 per cent. of instances calves from tuberculous mothers are born diseased). Bang recognised that only a conservative method could succeed in a country like Denmark, which in 1892 was known to have about 80 per cent. of its cows affected. He considered it would be wasteful, even if practicable, to slaughter all reactors when the great majority show limited and quite insignificant lesions which *may* never become otherwise. The cows were all tested and reactors were kept separate from non-reactors, either in separate buildings or in a partitioned building. Cases actually showing symptoms of infection were slaughtered as they arose. Attendants and utensils were kept separate for the two groups. The calves of both groups were kept. Those from the reacting group were removed from their mothers at birth, being only allowed the colostrum on the first day, and thereafter pasteurised milk from their mothers or the tubercle-free milk of the healthy group, and they were housed with the healthy herd. The healthy group was tested every six months and any reactor at once removed to the reacting group. In this way the non-reacting group gradually increased in size, and the reacting group diminished till it was possible so to reduce the numbers of the latter that the remaining few could be slaughtered, the premises disinfected, and the healthy herd be kept healthy by annual or bi-annual tests.

Bang found there were difficulties, however, in that the farmer was not always alive to the need for complete separation of the two groups, or that an occasional animal might pass the test and be not completely free of infection, or only in the incubation stage, and that consequently in some cases he kept getting a small percentage of reactors in the healthy group. If the farmer had two farms on which to divide his groups the method was much easier.

Later, Bang believed it was better not to do an initial test of the cows, but only the calves and heifers, separating the healthy among these as the nucleus of the healthy herd.

Bang's method is necessarily a long process, but it has been amply demonstrated in many countries that tuberculosis can be eradicated where the method is carefully and intelligently carried out. Where it has failed it has been due to a lack of facilities for efficient separation of the healthy and reacting groups, or a lack of sufficient technical education on the part of the agriculturist to enable him to carry it through. In Britain there has been a lack of demand for a tubercle-free milk at a higher price, consequently the farmer had little incentive to try and produce it.

Bang denies that the method is inapplicable to the small farmer, and that it is expensive. He quotes the following example of a herd:—

In 1904.—All tested and all reacted. Nothing done. Later two died and many sold at a low price. Many pigs affected.

In 1912.—15 cows. All tested and all reacted. A small com-

partment prepared in a barn for calves, new born and bought in.

In 1913.—Two of the isolated calves reacted, one being a bought in calf and the other a calf fed on raw milk.

In 1914.— Healthy herd 13 animals. Reacting herd 13 animals.

In 1915.—Healthy herd 22 animals. Reacting herd 6 animals. (These were sold early in 1916.)

In 1916.—Healthy herd 26 animals

In 1915 the cowshed was disinfected and the healthy herd put in it, the reactors being put in the barn.

Total actual expense ten shillings to buy boards to fit up the barn.

In Denmark the State provides free veterinary assistance, gives compensation for early slaughter, and destroys udder and womb cases (in 24 years 14,000 have been destroyed), yet Bang thinks the disease there is "almost as frequent" as it was 25 years ago.

Bang believes that eradication will only be attained when the breeder bestirs himself, and says "till we have a practical method of immunisation" the only thing is to educate the agriculturist in this matter.

In Sweden good results in freeing herds of the disease have been obtained by Bang's method.

In Norway the disease is slight in its extent and has been successfully dealt with by tuberculin testing and the slaughter of reactors. The Norwegians drink much raw milk and tubercle free milk commands a higher price.

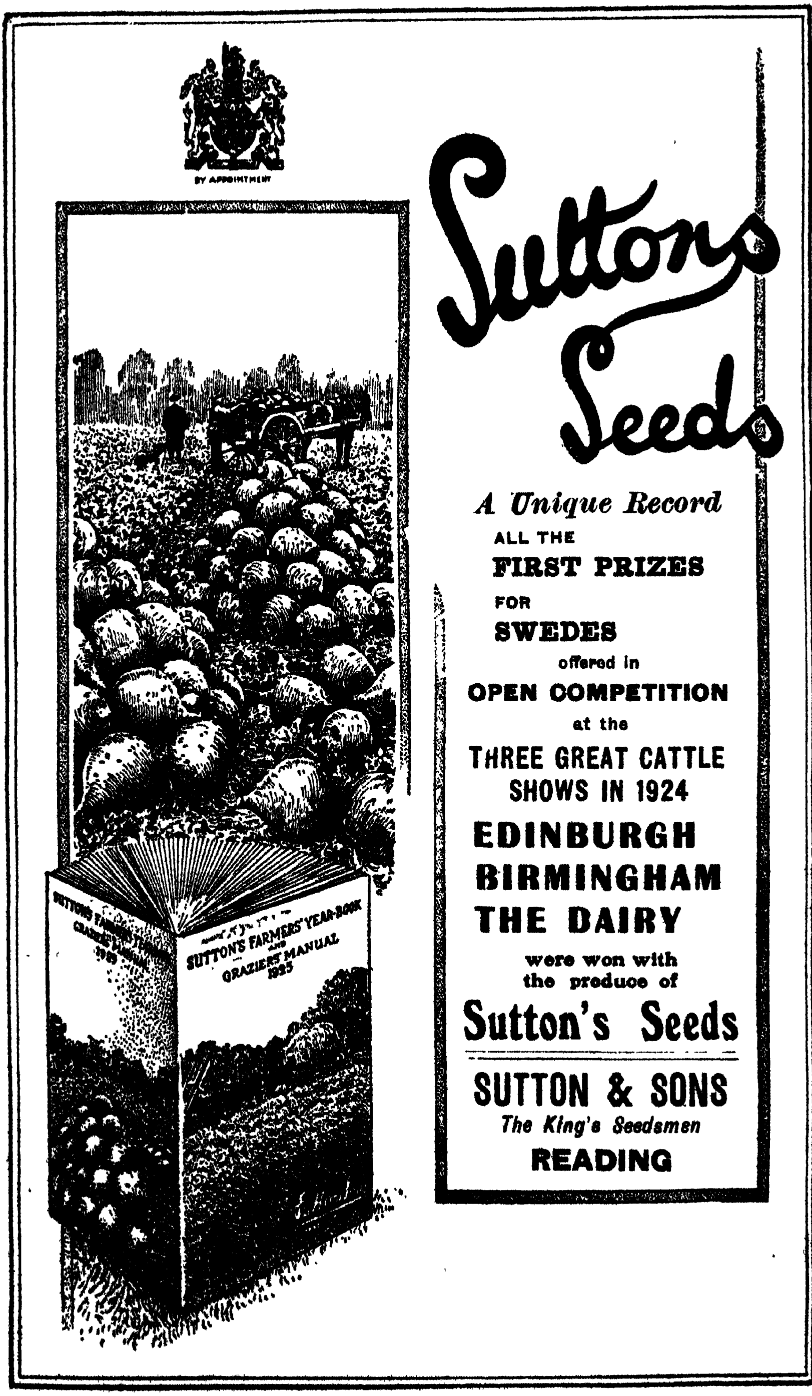
In Germany in 1909 Ostertag introduced his modification of Bang's method, in which all the cows are regarded as infected, only the calves being separated and tested. The State, farmers' Associations and owners co-operate. Ostertag showed from slaughterhouse statistics in Germany that tuberculosis doubled in the years 1895 to 1910.

In Hungary good results are claimed from merely keeping the calves separate except when they are allowed in to suck their mothers two or three times a day. This brief exposure is nothing like so dangerous as constant cohabitation. There is more risk of getting reactors in the healthy group by this method.

Holland tried compulsory testing, the sale of reactors for slaughter, the slaughter of clinical cases, and the payment of compensation, but the policy had soon to be modified on the ground of expense.

The immunisation of bovines against tuberculosis has been the subject of experimentation for many years.

A very large number of investigators, working mainly with guinea-pigs, have endeavoured to confer immunity by using dead tubercle bacilli, or extracts made from them, but the result has been to show that they confer only a moderate degree of immunity, which is of brief duration. Many years of experience have led to the conclusion that only living bacilli are of any real value in conferring immunity.

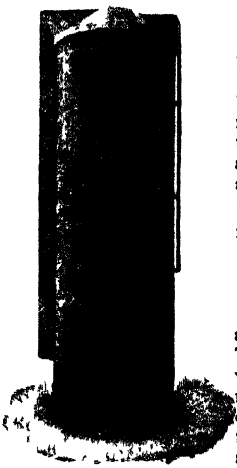

BY APPOINTMENT
Suttons Seeds
SUTTON'S FARMERS' YEAR-BOOK AND GRAZIERS' MANUAL 1925
A Unique Record
ALL THE
FIRST PRIZES
FOR
SWEDES
offered in
OPEN COMPETITION
at the
THREE GREAT CATTLE
SHOWS IN 1924
EDINBURGH
BIRMINGHAM
THE DAIRY
were won with
the produce of
Sutton's Seeds
SUTTON & SONS
The King's Seedsmen
READING

THE "SCOTT" SILO

— OF —

Reinforced Concrete

IS UNEQUALLED FOR QUALITY & PRICE.



It is the Best and Cheapest Ensilage store-house that has yet been offered.

The "SCOTT" Silo requires no maintenance; is proof against wind, storm and vermin.

We are now Agents for the

"PAPEO" ENSILAGE CUTTER

and stock all Spares. This cutter is a little wonder; costs less money to run than other cutters, goes through more work, and does not choke.

JAMES SCOTT & SON
(ABERDEEN), LIMITED,
433-435 Union St., ABERDEEN.

Sow Now

and reduce your Feed Bill from 50 to 75 per cent.

Toogood's World's Best Swede, best for latè feeding; Toogood's Monarch Swede, unequalled for early feeding; Toogood's Imperial Green Globe Turnip, quickest growing and most productive; Toogood's Giant Forage Maize, Improved Kohl Rabi, Essex Branching Rape, Mustard, Spring Vet hes, etc. Let us specially quote for your requirements. Ask for our free 80-page FARM SEED CATALOGUE and our free GARDEN SEED GUIDE. When desired, we give expert advice freely.

Toogood & Sons,
Ltd.,

The King's Seedsmen,

SOUTHAMPTON.

PREFER —

FRENCH POTASH

FOR ALL YOUR CROPS.

KAINIT, EXTRA KAINIT, POTASH SALTS,
(14%) (20%) (30%)

MURIATE AND SULPHATE OF POTASH.

Supplies from { **THE ABERDEEN LIME CO., Aberdeen** / **J. & J. CUNNINGHAM LTD., Dundee, Leith, Berwick** / **ALEX. CROSS & SONS, Glasgow** } *and Branches.*

Leaflets and Information from—

J. GORDON, B.Sc. (Agr.), French Potash Mines, 137 GLASGOW ROAD, PERTH.

Von Behring in 1902 introduced his method of immunising calves with dried living human tubercle bacilli, giving them two injections each. He found that an appreciable immunity could be given, in that the inoculated animals four months later resisted a dose of virulent bovine bacilli injected into the veins, whereas uninoculated control animals succumbed to this injection. This method was widely tried in various countries, and it was shown that the immunity conferred would last over a year. Unfortunately it was also found that such a method of immunisation must be regarded as highly dangerous to the public health. It was shewn that the human bacilli could remain alive and active in the inoculated animals for as long as two years, and that probably they could settle in the udder and set up dangerous lesions there, giving off virulent human bacilli in the milk. The same objections applied to attempts at immunisation by a single injection of human bacilli as was introduced by Koch and Schuetz. Klimmer tried immunisation by means of human tubercle bacilli deprived of their virulence, but further tests of the method showed that any good results obtained might equally as well be attributed to the hygienic preventive measures adopted as to the vaccine.

Heymans tried placing living human and bovine tubercle bacilli enclosed in a protective membrane under the skin, the idea being that the products of the bacilli could pass into the system and immunise without the bacilli themselves getting there to cause damage. Good results were claimed, but a Belgian Commission which studied the method failed to substantiate the claims.

M'Fadyean in 1913 carried out immunisation experiments upon cattle with the avian tubercle bacillus and found that it conferred a markedly increased power of resistance to infection with the bovine bacillus.

Immunisation experiments with living virulent bacilli are open to the obvious defect that one cannot ensure the destruction of the bacilli in the vaccinated animal's system; indeed the immunity conferred seems to be dependent upon the persistence of the bacilli in the body as living organisms. This is, of course, a most serious matter with the human bacillus.

Many investigators have endeavoured to modify the living tubercle bacillus in such a manner that it would be harmless when inoculated into bovines, and yet would retain the power of persisting alive in the body and conferring immunity to infection with virulent bacilli. For example:—

Vallée has used an equine strain of tubercle bacillus for twenty years in his experiments, a strain so modified that only a comparatively very large dose will infect a guinea-pig.

Friedmann used a strain of the bacillus grown in cold-blooded animals in order to modify it.

Arloing used a strain grown for long periods at a temperature above that of the body, but below the temperature which would be fatal to the bacillus.

Calmette and Guérin modified the bovine bacillus by growing it for many years upon potato, treated with glycerin and ox bile.

It has long been known that an animal which is an apparently healthy reactor to tuberculin, that is to say an animal with a

tubercular lesion somewhere in its body in a semi-quiescent state, shows a considerable resistance to experimental infection with tuberculosis. Such an animal will resist an experimental dose of tubercle bacilli which will kill healthy non-reacting animals. In other words an animal with a small limited degree of tubercular disease in its body is in a better condition to resist further tubercular infection than a healthy animal. In human beings it has been found that children with tubercular glands seldom become affected with lung tuberculosis as adults. It will be readily understood that it would be impracticable to make an animal actually tuberculous in a small degree experimentally, in order to protect it against tuberculosis in a severe degree contracted naturally. Such a method of procedure could not be controlled. The fact, however, points out that the most likely method of conferring a substantial immunity over a considerable period by vaccination would be a method by which the modified bacilli given in the vaccine persisted alive in the inoculated animal over a long period retaining their property of giving immunity, but without the property of multiplying and setting up disease.

Of the modified bacilli mentioned above, Friedmann's bacilli from cold-blooded animals multiplied at the seat of injection and caused serious lesions, and Arloing's vaccine did not confer sufficient immunity. Vallee's equine strain is open to the practical objection that the bacilli, as shown by him, multiply at the site of inoculation.

The most promising of all inoculation methods up to the present is that of Calmette and Guérin. After growing the bacillus for thirteen years upon glycerine bile potato, they found it had quite lost its virulence for all species of animals and man. At the same time it had lost the power of making an animal inoculated with it react to tuberculin. The bacillus was then transplanted on to potato medium without bile, when it was found to have regained the power to make inoculated cattle react to tuberculin, but remained non-virulent.

In November 1912 Calmette and Guérin commenced experiments upon cattle with this modified avirulent strain, which they call B.C.G., to see how long immunity lasted in housed vaccinated animals exposed to tubercular infection. They published very encouraging results in 1920, telling how their work was interrupted from the latter half of 1915 owing to the German occupation of Lille. Their experiments were resumed in 1922 and justify the claim that the vaccine gives protection for a period of about 18 months against a dose of virulent tubercle bacilli injected into the veins, a dose which proves fatal to unvaccinated cattle in sixty days.

The B.C.G. tubercle strain was at first used in only small doses, and it was found that the inoculated bacilli were destroyed at the site of injection under the skin in due course, the immunity conferred by them diminishing as the bacilli disappeared. It has now been shown that comparatively large quantities of the bacilli injected subcutaneously into the dewlap form a small quite painless swelling the size of a pigeon's or hen's egg. In the swelling the bacilli do not multiply, but they persist alive for over a year, being

gradually overcome and destroyed by the cells of the tissues surrounding the swelling. The immunity lasts as long as the lesion lasts. The fact that the inoculated animal reacts to tuberculin indicates how nearly this artificial process resembles that referred to above in which a semi-quiescent natural infection protects an animal against further infection to a large extent, but makes it a reactor to the tuberculin test. The reaction in the inoculated animal, which begins about the 20th day, means protection and not infection.

This B.C.G. fulfils, apparently, the requirements which we have seen to be desirable for an anti-tuberculosis vaccine. It is without danger, it confers an immunity lasting well over a year by persisting alive at the site of injection, and it does not multiply in the inoculated animal's body. Moreover it does not affect or inconvenience the inoculated animals in any way. It is incapable, under any conditions, of itself producing tuberculosis.

It remains to be seen whether the results so far attained are borne out by extensive field trials under practical conditions, and for this purpose the Pasteur Institutes at Paris and Lille are issuing the vaccine free for trial upon herds.

The method adopted for these extensive trials is as follows :—

Vaccination is done upon calves during the first fortnight after birth and thereafter upon about the same date annually. The inoculation is done into the upper third of the dewlap, making the injection well into the subcutaneous tissue. The vaccine is sent out in separate doses of 10 cc. for each calf, and as it consists of living germs to which a preservative must not be added, it must be used within a few days of receipt.

No special care is taken of the vaccinated animals. It is advisable to know the extent of infection in the herd beforehand by subjecting it to the tuberculin test, but there need be no separation of reactors and non-reactors, the calves are allowed their mother's milk without pasteurising, and are not kept separate. At the same time vaccination does not relieve the owner from his responsibilities in the matter of removing clinically affected animals from his herd and practising cleanliness and disinfection in his byres. Nothing is to be gained by exposing his protected calves to gross contamination.

Provided inoculation does what is expected of it, a herd of immune animals could be raised in five years.

A consideration of the future leads one to conclude that tuberculosis will probably never be eradicated from the cattle of this country by unduly restrictive and irritating State measures. It is very nearly 30 years since the Royal Commission stated that measures against meat and milk are at the best "uncertain palliatives" as measures against the disease.

Inspection of meat and milk are indispensable in the interests of public health. The public are entitled to all possible protection against buying meat from diseased animals even if the danger from meat may be small, and against buying milk which is a real source of danger to children, but inspection of meat and milk should go hand in hand with co-operative efforts at prevention, between the State, local authorities and agriculturists.

At the root of any campaign against bovine tuberculosis must lie improvement in the education of the agriculturist in such matters. In this work the Agricultural Colleges have a golden opportunity which does not at present seem to be taken as full advantage of as it might be. Much might be done by the State providing special anti-tuberculosis lecturers, who could with advantage be recently graduated veterinarians specially trained in anti tuberculosis measures, to go round the Agricultural Associations giving lectures and demonstrations to farmers, and, in consultation with the local veterinary surgeons, point out practical measures.

It is all to the good that Associations are being formed by the owners of tubercle-free herds and that special sales for tubercle-free cattle are coming into vogue.

The tuberculin test is a valuable scientific means for the detection of the disease, but it is in urgent need of State protection against abuse. Its manufacture could readily be standardised and limited to a few centres, and its importation might be prohibited or allowed only from a few known reliable sources such as the Pasteur Institute in Paris. Its distribution might be controlled and penalties might be inflicted for improper use. The matter is of sufficient importance for the Government to set up a Committee to work out a scheme.

Free tuberculin testing might be provided by the State on the understanding that reactors are branded and used for breeding only, being kept separate from the non-reactors, their milk pasteurised and calves separately housed; in other words free testing at State expense if Bang's system be adopted. Any system which allows reactors to be passed on to someone else is only playing at eradication.

The destruction of clinical cases as provided for in the Tuberculosis Order of 1914 does not have a great effect in decreasing the number of reactors in herds, but it is a very necessary measure in the interests of public health. It can be done only by providing sufficient veterinary inspection, and compensation must be given for destruction.

Local authorities can do good by tracing infected milk to its source and advising the owners on measures which would lead to the discontinuance of contamination, or providing for pasteurisation of all milk other than that from tubercle-free herds. Such methods are expensive in travelling and laboratory expenses, but since the public health demands it, should be carried out as far as is possible. Pasteurisation of milk can be carried out without real depreciation in its nutritive value, but as an eradication measure it is without value.

Steps should be taken to prevent infected dairy products being given unsterilised to pigs.

Vaccination, if the present extensive and extended trials show that it confers immunity against all reasonable risks of infection, will revolutionise the anti-tuberculosis campaign. The stock could be rendered immune without interfering in any way with routine, without separation of reacting and non-reacting adults, and without separation of calves from their mothers. It could

not, however, be made an excuse for not getting rid of clinically affected animals or for not practising ordinary cleanliness and disinfection measures. Vaccination against any disease will never allow of continual exposure to gross infection.

The campaign will require the co-operation of all. The present position is bad, but that cannot excuse a negative policy on the part of anyone. The State's policy should be one of helpful guidance, but it should be somewhat more active than we have evidence of at present if much impression is to be made upon the prevalence of the disease.

THE MILK INDUSTRY OF AMERICA: SOME OBSERVATIONS.

RENWICK HUTSON LEITCH, M.A., B.Sc. (Agr.), B.Sc., N.D.A. (Hons.), N.D.D.

PART I.

DURING a recent visit to America the writer was afforded a special opportunity of studying in some detail various aspects of the milk supply, and the following descriptive remarks embody in a summarised form the results of his observations.

CONTROL OF THE MILK SUPPLY.

The milk supply of all the large towns and cities in America is systematically controlled from the source of its production till the time the milk is delivered to the consumer. This control starts at the farm and extends to the country collecting or receiving stations, to the milk in transit, to the arrival of the milk at the railway terminals, to the treatment of the milk in the town depots, and to the bottled milk in the delivery waggons.

Sanitary regulations regarding the production of milk on the dairy farms of America are generally more rigid and more stringently enforced than those prevailing in Scotland, with the result that the milk supply of American towns and cities is unquestionably superior to ours. The improvement which, in recent years, has taken place in the market milk of America is due principally to the activities of the Public Health Departments of large cities, and to the co-operation of the Dairy Companies who purchase, handle and distribute the farmers' milk. To some extent it is also due to an active educational campaign conducted by the dairy extension services of the Colleges and Universities, and to the help afforded by the Federal Department of Agriculture. But the Public Health control has been the greatest factor in the progressive improvement of the milk supply. The Departments of Health in large cities like Ottawa, Toronto, Detroit, Chicago, Philadelphia and New York exercise a very firm supervision over the producers of milk in the region of supply.

Farm Inspection.—Before a dairy farmer is allowed to send milk to cities like Ottawa, Toronto or Chicago he must first secure a license or permit to ship milk. The granting of this

permit is conditional on his cattle, premises and equipment being satisfactory to the Inspector of Foods of the Health Department of the city to which the milk is to be sent. This means that each city controls the milk supply of all farms which send it milk, irrespective of the location of these farms. Frequently supplying farms are in different States from the city itself.

When a license to sell milk is applied for, the farmer's cattle are subjected to a clinical examination; any animal showing obvious symptoms of disease, and especially of tuberculosis, must be eliminated. The structural arrangements of the byre and milk house, the cleanliness of the premises, the feeding and care of the cows, the condition of the utensils, and the method of handling the milk at the farm are critically examined. Facilities for cooling the milk at the farm must be good—an important proviso where market milk is being produced, and one which is rigidly insisted on. Special attention is directed to the health of the dairy workers, and intimation is made that no one suffering from any form of communicable disease—as determined by medical examination—is to be allowed access to the cows, or may take any part in the production or handling of the milk.

In most cases the producer applying for a license is obliged to make some changes, both in his equipment and in his methods. Licenses are not issued until the necessary improvements have been effected.

In his report to the Health Department on the condition of the farm of the prospective milk supplier, the Inspector makes use of the now familiar score card. The score card points out those factors which have a bearing on the sanitary conditions under which the milk is produced. It rates in figures the health of the cattle, the condition of the water supply, the food of the animals, and the equipment and cleanliness of the byre, the milk house and the utensils. The form of the score card used in Toronto is worthy of special note, because it is better balanced than many that have been employed in past years.

Public Health Department, City of Toronto:

FARM SCORE CARD.

COWS	Health	5	
	Condition	3	
	Clipped Flanks (clean)	10	
	Clean Udder	10	
	Water Supply	5	
	Feed	2	
		—	35
STABLE	Cleanliness	12	
	Removal of Manure	4	
	Construction	5	
	Light	4	
	Ventilation	5	
	Cubic Space (500 feet)	4	
	Stable Yard	6	
		—	40
			—
		Carry forward,	75

		Brought forward,	75
MILK HOUSE	Construction and Location	4	
	Cleanliness	5	
	Care of Utensils	4	
	Cooling Facilities	5	
	Small-mouthed Pail	7	
			25
	Total		100

In the United States the score card most commonly used is that issued by the Dairy Division of the U.S. Department of Agriculture.

The supervision over the milk producer does not end with this preliminary inspection and registration. A periodical and systematic examination of all licensed dairy farms which supply milk to the city is made by the Health Officers. The city of Detroit draws its milk supply from about 10,000 farms, and yet according to a printed official statement "each of these farms is thoroughly inspected at least once a year and re-inspections are made whenever it is found necessary." In this routine inspection attention is directed to the general health and care of the milch cows, the water supply for the animals, the sanitary condition of the byre, the health and cleanliness of the milkers, the facilities for sterilising all dairy utensils and for effectively cooling the milk. When it is found that insanitary conditions exist at the farm, or that the management of the milk is unsatisfactory, or that communicable disease is present among the dairy workers, or that the cows are unhealthy, the milk supply of that farm is excluded. The presence of a diseased animal in a herd is *prima facie* evidence that the milk of the diseased animal is sold contrary to law.

A farmer whose milk supply has been stopped for any of the foregoing reasons is not allowed to send milk to the city again until he has proved to the satisfaction of the official inspector that he has effected the necessary improvements and eliminated the faults. At the time of my visit to Ottawa (23rd October 1924), more than twenty farmers were, for the time being, excluded because of bad or faulty conditions at the farm. Of the 25,000 farms supplying milk to Chicago in the year 1922, 145 were excluded and 122 released after the objectionable features had been eliminated, and the improvement verified by re-inspection.

The enforcement of these very direct measures has done much to improve the sanitary conditions of the American dairy farms, and to safeguard the city milk supply. The Public Health authorities rightly believe that the control of the milk supply should begin at the source of production, because if conditions are bad here, the milk cannot possibly be sound. The Departments of Health do not concern themselves with the difficulties which the farmer has to face; they look primarily to the health of the consumer, and for this reason they aim at suppressing all milk which they consider unclean or unsafe for public consumption. Experience in America has shown that unless some measure of compulsion is applied in the case of the unsatisfactory producer,

little improvement need be expected in the milk supply. Prosecutions of offending dairymen in Courts of Law are far less effective than the simple cutting out of their milk supply. The latter is by far the severer penalty. When it was suggested that such a system of control was harsh and unsympathetic, the reply invariably made was that it produced results and that the end justified the means.

Inspection of the Milk en route.—The checking of the farmer's milk supply implies a well co-ordinated and highly organised system of inspection. The milk of the individual suppliers is checked, either at the country collecting stations (where it is bulked, cooled and dispatched by rail to the city plants) or at the city platforms, or on its arrival at the town depots. The work of sampling the raw milk is carried out by a staff of specially trained inspectors appointed by the Health Departments. The Department of Health in New York employs fifteen milk inspectors to cover the production end, and a staff of twenty-three milk inspectors in the city itself. In Chicago there are twenty-one inspectors at different parts of the milk route. The duty of the route inspector is to examine the sealing of the cans, to take temperature readings of individual cans and consignments, and to make sediment tests. A high temperature or evidence of excessive sediment in the farmer's milk may cause its immediate rejection.

(a) *Temperature Test.* — Generally speaking the maximum temperature allowable in milk shipped to the city is 65°F., but most cities demand a lower temperature than this. Chicago and New York impose a limit of 60°F., while the Milk Ordinance of Detroit requires a maximum delivery temperature of 50°F. Stress is laid on temperature, because if milk arrives at the city at a temperature of 70° to 80°F., the probability is that its bacterial content has increased beyond the point at which pasteurisation is likely to be effective. In 1922, 2229 cans of milk were returned to shippers on account of the milk registering a temperature over 60°F. on arrival at Chicago. In 1923 the milk inspectors of the city of Detroit rejected 7301 cans of milk (equivalent to 1·6 per cent. of the total supply) on account of high temperatures alone.

(b) *Sediment Test*—Great stress is laid on the sediment test. It is universally employed throughout the States and in Canada. In making this test a quart of milk, usually taken from the bottom of the can or container, is forced by air pressure through a special cotton wool disc (1 in. in diameter) retained in the neck of a milk bottle. The amount and nature of the sediment is carefully scrutinised. Three grades of sediment deposit are recognised :- (a) *clean*—practically no evidence of sediment, (b) *suspicious*—visible traces of sediment, (c) *dirty*. The producer of milk of the second grade is cautioned; milk of the third grade is condemned. The inspector is empowered to pour such milk down the sewer; if its return is demanded, the condemned milk is coloured with aniline dye to make it unfit for any purpose of manufacture or for sale (*e.g.*, Montreal and Omaha). In Toronto the procedure is even more drastic. If a supplier whose milk is rejected claims it for feeding purposes, it is shipped back to him at his own expense. But the can may bear a red label with the following inscription in large letters:—"Condemned Milk, Unfit for Human Food."

The condition of the milk churns also receives the inspector's attention. In 1922, 632 milk cans belonging to shippers of milk to Chicago were destroyed because of their rusty and leaky condition. In Detroit 1301 cans were condemned, and 6142 cans were returned on account of ineffective cleaning and sterilization (1923).

(c) *Bacteriological Tests.*—In addition to the physical examination made by the inspector, samples of the raw milk from the farmers' cans are periodically transmitted to the Public Health Laboratories for bacteriological examination. When a high count of any sample is registered, the sender of such milk is notified of the result, and is requested to exercise greater care. If subsequent improvement is not shown, the source of supply is ruthlessly cut off. Generally speaking, each city imposes definite bacterial limits on milk intended for pasteurisation. According to official figures, 91·7 per cent. of the raw milk samples tested in the Public Health Laboratories of Chicago in the year 1923 were below 100,000 per c.c.

(d) *Chemical Tests.*—Milk is systematically tested for fat, solids not fat and for adulteration by water. The chemical standards for milk are quite rigid, and generally are higher than those demanded in this country. While New York and Chicago require a minimum of 3 per cent. butter fat and 8·5 per cent. solids not fat, Detroit demands 3 per cent. butter fat and 12·5 per cent. total solids; St. Paul, 3 per cent. butter fat and 8·75 per cent. solids not fat; Toronto, 3·25 per cent. butter fat and 12 per cent. total solids; Omaha, 3·2 per cent. butter fat and 8·75 per cent. solids not fat. Milk which falls below these chemical standards is regarded as adulterated milk. The "appeal to the cow," so familiar to our courts of law, is not recognised. If the milk falls below the fat standard and continues low after due warning has been given, the farm supply is eliminated.

Certified Milk.—In the large cities of Canada and the States only two grades of milk are recognised—(*a*) Raw Milk from accredited herds, commonly designated Certified Milk, and (*b*) Pasteurised Milk. The conditions relating to the handling of certified milk are practically the same as those imposed in this country, but the score card requirements are if anything more stringent. On certified milk farms the cows are tuberculin tested at least once a year. In the case of Chicago there is also a compulsory physical examination of all the farm attendants monthly, the testing for sore throat infections receiving special attention.

Certified milk is defined as the product of tubercle-free cows, produced under sanitary conditions, cooled, bottled and sealed on the farm. It must conform to definite chemical and bacteriological standards, and be delivered to the consumer within a stated number of hours (usually 12) from the time of production. The minimum fat content of certified milk varies in different districts; while Chicago and Montreal demand not less than 3 per cent. butter fat, Toronto requires 3·5 per cent. and Omaha a 4 per cent. fat standard. The bacteriological limit commonly imposed is 10,000 per c.c. (at any time before delivery to the consumer), but some cities require lower counts in winter and allow of a slightly higher

count in summer. For instance, the requirements in Montreal are 10,000 per c.c. for the winter months and 15,000 for the summer months. Toronto, on the other hand, requires 10,000 in the summer months and 5000 in the winter months. The bacteriological standards of such high grade raw milk are apparently reached without any great difficulty. Professor Starkey, a member of the Medical Milk Commission of Montreal and Professor of Hygiene at the University, assured me that Montreal's certified milk at the date of my visit contained only 200 organisms per c.c.!

On account of the greater expense in producing and handling certified milk the demand for it is relatively small. Even the better classes are disinclined to pay the enhanced price demanded (which is 25 cents per qt. in most cities). In Chicago only seven farms are producing certified milk for the market; in St. Paul from 1 to 2 per cent. of the milk is of the certified standard; in Minneapolis 0·6 per cent. In Toronto from 450 to 500 gallons of certified milk are sold daily.

In a number of cities a Grade A. raw milk (the product of tuberculin tested cows, but the bacteriological requirements of which are not so high as for certified milk) is sold. In New York 2 per cent. of the milk is of this type; in Omaha 50 per cent. of the milk supply is of such a character.

Inspection and Control of the Milk Supply within the City.—Before a prospective milk dealer can engage in the milk business, he must first secure a permit or license from the Health Department. Permits are not issued indiscriminately. The applicant must first satisfy the Health Authorities as to his fitness to engage in the milk industry; in Chicago many persons have in recent years been refused permits because they showed on verbal examination a lack of the necessary fundamental knowledge requisite for the milk business. Again before a dealer can operate, the premises in which the milk has to be handled and the equipment used for treating the milk must be of a satisfactory nature. Here again the score card is held in reference. A score of less than 60 points on an average will disqualify any dealer or firm.

Note that licenses are granted in respect of individual dealers and are not transferable. If a dairy changes hands the purchaser must, if he wishes to continue in the business, obtain for himself a new license.

A further proviso made by most City Milk Ordinances is that the sources of supply of the milk dealer must be approved of by the Health Department. A town dairyman is not allowed to purchase and sell milk from uncontrolled sources. This means that all streams of supply are subject to the conditions laid down in the City Ordinances. For this reason the control of a city's milk extends to supplying farms in districts which may be far removed from the centre of distribution. New York for example exerts its authority over farms 500 miles away. In America the Departments of Health have a long arm.

Throughout the year all milk plants and distributing depots in the city are periodically inspected and reported on. The presence of contagious disease among the workers, inefficient operation of the plant, or bad sanitary conditions at the depot leads either to

temporary or to permanent exclusion. The methods of sterilising apparatus are systematically checked, both by practical examination and by bacteriological tests. In Chicago in the year 1922 the number of inspections of milk depots, milk stores and city pasteurising plants was 21,564; 5 licenses were temporarily revoked.

Development of City Dairies and Milk Companies.

An outstanding feature in the dairy industry of America is the development of large milk companies which purchase the farmers' milk at the country at collecting stations, transport it to the town, and distribute it to the consumers. The small milk pedlar, so familiar in the municipalities of Scotland, is now practically unknown in America. The main reasons for his disappearance are (*a*) the enforcement of a general scheme of pasteurisation and bottling of milk; (*b*) the Public Health requirements in respect of registration of premises and the supervision of personnel and equipment of all dairies, and (*c*) the economic factor. The machinery, premises, and general equipment necessary for pasteurisation and bottling of milk are expensive—too expensive for the small dealer with only a limited capital. The result is that, except in small towns and villages, he has practically disappeared. In reality the cost of his services was too high for the community, and usually he did little or nothing to improve or safeguard the milk supply. To quote a single instance of the effect of imposing a general scheme of pasteurisation on a community; before the year 1916, when certain grades of raw milk (not certified milk) were allowed to be sold in Chicago, the number of milk dealers was 1300; after universal pasteurisation was enforced, the number was reduced to 580. In the metropolitan districts of New York, which has a population of 2¼ million, there are 35 large pasteurising plants and 350 distributing depots.

The large Dairy Companies draw their milk supply from a wide area and from a large number of farms. In order to facilitate the work of handling, treatment and transportation of the milk, each company has organised and owns a chain of collecting stations in the country to which the supplier's milk is sent. Usually there is one collecting station within every five mile radius in the area of supply. This system works extremely well because it enables the dealers to control effectively the milk at the very source of supply.

Preliminary to its despatch to the collecting station, the cooling of the milk at the farm is insisted on, and no milk is received which exceeds a temperature of 50 to 55 degrees F. Some milk companies will accept warm morning milk if delivered before 8 a.m. But the proviso is made that such milk be kept separate from the evening's milk, which, in all cases, must be cooled immediately after its production to a low temperature. Each farmer's milk as it reaches the station is examined physically, tested for temperature, acidity, and for the presence of sediment. The sediment test, made on the spot and in the presence of the producer and his neighbours, is a striking object lesson on clean and dirty milk production.

The milk is paid for on a basis of its weight and its fat content. The standard of reference is milk of 3·5 per cent. fat; for every 0·1 per cent. fat above this, a bonus of 4 cents per 100 lbs. is paid; for every 0·1 per cent. below this level a deduction of 4 cents per 100 lbs. from the common flat rate is made. The butter fat percentage is determined by the Babcock Test. By following this principle, Dairy Companies have found no difficulty in getting a milk of a satisfactory fat percentage.

In case of Grade A. raw milk, a recent development is to pay for milk not only on a basis of its quality, but also on its bacterial count at the time of delivery. Some large concerns have adopted this practice with excellent results. A specific case may be quoted. The Borden Dairy Company of New York City initiated a plan of paying premiums for Grade A. milk of low bacterial count in the year 1917. The following table shows the immediate effect on the producer's milk of instituting such a procedure.

Percentage of Producers' Milk.

	Below 25,000 per c c	Between 25,000 and 100,000 per c c.	Between 100,000 and 500,000 per c c.	Above 500,000 per c.c.
	Per cent.	Per cent.	Per cent.	Per cent.
July 1917 . . .	7	20	60	13
September 1917 . .	75	15	10	0

Having graded up the milk to a standard of less than 25,000 per c.c., the Company then started a differential payment for milk below 25,000 per c.c. and for milk below 10,000 per c.c. The following table shows the progressive improvement in succeeding years:—

Percentage of Producers' Milk.

	Below 10,000 per c.c.	Between 10,000 to 25,000 per c.c.	Above 25,000 per c.c.
	Per cent.	Per cent.	Per cent.
1919	53	26	21
1922 . .	70	20	10
1923	79	15	6

The premiums actually paid were as follows:—

Below 10,000 per c.c. . . .	Flat rate, plus premium of 40 cents per 100 lbs.
Between 10,000 and 25,000 per c.c.	Flat rate, plus premium of 25 cents per 100 lbs.
Above 25,000 per c.c. . . .	Flat rate, but no premium.

In this case the flat rate is based on a 3 per cent. fat standard, and for every ·1 per cent. fat above this, an additional premium of 4 cents per 100 lbs. is, as already indicated, paid to the producer. This Company reports that, in connection with efficient

pasteurisation, consumers quickly recognised the improved quality of the Grade A. pasteurised milk; rapidly increasing sales were realised. In 1922, 427,000 dollars were paid as premiums to the producers of this low count milk, and 15 million gallons were sold. It may be noted that 20 per cent. of milk issued by the Borden Dairy Company is of the Grade A. pasteurised standard.

The farm milk is brought to the collecting station in cans of 8 to 10 gallon capacity. These cans are much more easily handled than the larger 17 gallon milk churns which are so common in our country. The milk cans generally are the property of the farmer, and are less commonly owned by the dealer. It has been found that when the cans are provided free by the milk company, the farmer does not usually take as much care of them as when they are his own property. In Toronto, however, the City Ordinance requires that dairies in the municipal areas must own and control all milk cans, and that after use they must, before being returned to the farmer, be washed, sterilised and sealed.

But even when the cans are the farmers' property, it is the invariable custom for the milk companies to wash and sterilise them at the collecting stations before returning them to the farmer. This they do in their own interests. Can washing machines of a very efficient type are employed to do the work. This very real service which collecting stations perform is a boon to the farmer, who seldom has the equipment required for the work. It has repeatedly been shown that unsterilised or unclean cans are a prolific source of contamination in market milk. By eliminating this factor the milk companies have done much to improve the condition of the milk as it arrives at the depot. It may be mentioned that hot alkali water, steam and dry hot air are used for cleaning the cans.

A more extended use of can washing machines at our own creameries and milk depots is advocated, and it is suggested that in a case of small depots and creameries where the initial expense of installing an efficient can washer is relatively high, a charge of ¼d. per can might be made to pay for overhead. The installation of can washing machines, however, implies the standardising of the size of cans. Most types at present employed in America handle only the smaller sizes of milk churns, that is to say, from 8 to 10 gallon capacity cans.

At the collecting stations the milk after being checked and weighed is pooled, refrigerated and shipped to the city.

Internal Organisation of Dairy Companies.—The large milk companies which practically control the milk supplies of towns and cities are highly organised businesses, operated by keen commercial men, and staffed by efficient and well paid workers. The amount of capital invested in these organisations is very large. The Detroit Creamery Company, for instance, operates with a capital of over 3 million dollars.

On the staff of every milk company there is a dairy chemist, who, in virtue of the many duties he has to perform, must be a man of intensive training and experience and be endowed with a high degree of technical skill. It is this official who reports on

the chemical and bacteriological examination of all the milk supplied to the depot. It is he who is reponsible for the technical control of manufactured products like butter, cottage cheese, dried milk, condensed milk, dried buttermilk, ice cream, modified milk, fermented butter milk and dried casein. Often it is the chemist who suggests improvements in the machinery and equipment of the plant, for a knowledge of chemical engineering is requisite to his duties. Usually the chemist is a University trained man, and net infrequently he carries out technical research work on milk and milk products. As the milk company is largely guided by his advice on all scientific problems, it will be obvious that the chemist holds an important and responsible position. He is not, however, directly concerned with the economics of the business, this section of the enterprise being controlled and guided by the manager and a board of directors.

As an example of the development of the milk laboratory in a large dairy organisation, it may be stated that the Borden Dairy Company of New York has a staff of 35 laboratory assistants working under the direction of the chief chemist. The number of milk analyses carried out in a single month (November 1924) was as follows: 29,000 plate counts, 5000 microscopic counts and 2200 chemical analyses. For the year 1923, the number of analyses was 418,000, and for the year 1924 the total number of analyses was 543,400. The amount of media used annually (all prepared in the laboratory) is 3000 litres. The Hortvet Cryoscope is used for detecting added water in milk and the Majonnier Tester for ice cream control. The Breed Microscopic method is used for the rapid grading of raw milk intended for pasteurisation. In addition to analysis of milk and dairy products, the water supply, soap cleansing solutions, and soda tank steeps are all checked up, as are also the water and salt content of butter, and the composition of condensed milk and of dried milk. The chemist is also responsible for all the modified milk which is issued by the concern.

In order to comply with the City Regulations regarding the bacterial numbers in pasteurised milk, the chemist must exercise very careful control over the milk at different stages in the process of pasteurisation. In the event of a high count being found at any time in the finished product, it is his duty to determine the origin of this high count and to indicate by what method of treatment the high count can be overcome. Sometimes it may be due to imperfect sterilisation of constituent parts of the plant; sometimes it may be due to the bottles. Frequently, however, high counts are due to the presence of organisms which give rise to innumerable pin point colonies on the agar plates. There is some doubt as to the origin of these pin point colonies. They come up most frequently in fall or winter milk, and Dr. Hammond, the chemist to the City Dairy Company, Toronto, thinks that their emergence is simply due to the fact that the utensils and especially the farmers' cans are incompletely sterilised on account of the rapid reduction in the temperature of the hot water generally used for this purpose. On the other hand Dr. J. Vanderleck of the Ottawa Dairy Company is of the opinion that pin point colonies are closely associated with a presence of foam on the surface of the pasteur-

ised milk during the holding period. Foam interferes with effective pasteurisation, and on account of rapid surface cooling the organisms present in it are not subjected to the usual pasteurising temperature. Dr. Vanderleck quotes some findings from his own practical experience, of which the following is an illustrative example. In one batch of milk he found 20,000 bacteria per c.c. in the milk itself and 110,000 per c.c. in the surface foam.

Many of the organisms causing pin point colonies are of the thermophylic type, and are not wholly destroyed by the temperature of pasteurisation commonly employed, but they usually succumb when the temperature of pasteurisation on the completion of the holding period is raised about 10° F. for a few moments before the subsequent cooling. Hence it is a practice in some milk companies where a high count in the pasteurised milk is caused by the presence of these organisms, to boost the milk up to a temperature of 154° F. momentarily after it has been held at 143° for 30 minutes. The bacterial count of milk so treated is invariably low.

Processing of Milk at a City Plant.—In order to illustrate the method by which milk is handled and treated in a large capacity plant, the following description of the Bowman Dairy Company's plant (4149 S. State Street, Chicago) is set out.

This is a new plant and has only been in operation for nine months. It was specially designed to handle large volumes of milk, and the machinery and equipment is of the latest and most up-to-date type. Unlike others, the whole of this plant is accommodated on one main floor, and only the storage tanks for separated milk and cultured buttermilk are set on a raised platform. The building, which is close to a railway siding, is rectangular in shape and is extremely well illuminated internally by large rooflights.

Transportation of Milk.—The milk arrives at the depot on railroad car tanks from the country collecting stations. There are 12 of these special cars in use, and each railway truck houses two large glass lined tanks, each of which has a capacity of 6000 gallons of milk. Before these huge tanks are emptied into the truck tank which conveys the milk from the siding to the depot, the milk is agitated by a motor driven agitator for 15 minutes to equalise the fat. The temperature of the milk in these car tanks is usually low—35 to 40° F.—being thoroughly chilled before it leaves the country collecting stations. In these car tanks little rise of temperature takes place during transportation, even after a journey of 75 miles in hot summer weather. Each car container takes three quarters of an hour to empty.

Truck Tanks.—The truck tanks which convey the milk from the siding—where the car tanks arrive—to the depot across the road where the milk is treated are also glass lined. The car tank is emptied by air pressure; using a 15 lb. air pressure and a 3″ discharge milk-conducting pipe, the truck tank is filled in 6 minutes. The truck tank (of which the company owns seven in Chicago) holds 1500 gallons.

Storage Tanks.—Arrived at the depot, the milk is forced by air pressure from the truck tank to large capacity Pfaudler holders. There are in use three of these Pfaudler storage tanks, each of which has a capacity of 3000 gallons. During the time the raw

milk is held in these storage or supply tanks, the milk is agitated and if necessary brine cooled. The milk is kept in these containers until it is pasteurised. As a general rule it remains in the storage battery for a few hours only.

Pasteurising Plant.—There are in operation two pasteurising units of the internal tubular continuous flow type, each unit having a capacity of 10,000 lbs. per hour.

Before the actual pasteurising process begins, the milk is preheated to 75° F. preparatory to clarifying. The temperature of pre-heating, it may be noted, has a distinct effect on the amount of foam appearing on the milk. A high temperature of pre-heating inevitably produces a considerable amount of foam, a circumstance which is to be avoided as it is difficult to bring about effective reduction of bacteria in foamy milk.

From the pre-heater the milk passes to the clarifier in which it is centrifugally cleaned. From the clarifier the milk is pumped to the heating coils where it is raised to a temperature of 145° F. From here it goes to the continuous flow tubular "holder," through which it takes 30 minutes to flow.

The pasteurised milk then passes to the tubular cooler (built up of three sections, city water in the first, deep well water in the second, and brine in the last section) where it is reduced to a temperature of 40° F. The pump, which sends the milk through cooling coils, elevates the milk to a raised platform where it is held in a coil vat holder until it is bottled. In this intermediate storage tank, which has a capacity of 850 gallons, the milk is kept cold and slowly agitated by an internal brine coil.

Bottling Plant.—The bottling plant is composed of four units of the Milwaukee type which operate at the rate of 50 quarts or 60 pints per minute. These filling and capping machines are in constant operation for nine hours daily. The bottles after being filled and capped are put into crates and sent by an endless conveyer to the cold store, where they are held at a temperature of 35° F. until despatched. During the passage along the conveyer the capped bottles meet with a spray of water which washes off any milk on the cap or neck of the bottle. Special milk is iced in the crates.

Bottle-washing Plant.—The returned bottles are sent in crates by an endless revolving conveyer to the bottle washing machine, which is of the Michael Yundt type. At this plant there are two bottle washers in operation. Each machine is 12 pockets in width and cleans from 96 to 120 bottles per minute. The bottles are passed through three successive tanks containing hot caustic soda in solution. They are then rinsed by water under pressure and are finally sprayed with chlorinated city water. About 100,000 bottles are washed daily. It may be observed that the bottles after treatment are not dry but are quite sterile. The bottles after leaving the machine are drained and righted on to a conveyer which transports them to the filler.

Workers.—All the operatives are provided with white drill suits, and if necessary with white rubber aprons. In all cases they wear white rubber gum boots. A clean suit of overalls is provided for each worker daily, the clothes being washed and

sterilised in a private laundry in the plant itself. A small hospital, a toilet, a spray bath and a luncheon room are provided.

Power.—Electrical power is purchased from the city. The steam used in pasteurising and for providing hot water is generated by two 225 h.p. boilers, only one of which is in use at a time. Steam heat is also used for heating the building and for the can washing machines.

Refrigerating and Ice-making Plant.—Three 50-ton ice machines are used. The capacity of these is 30 tons of ice per day, operating on a 16 hour run. Note that all the ice used in the plant is made by these freezing machines. The cooling water, after circulating through the condenser, is sprayed into the outside air to cool it and is used over again in the condenser.

Atmosphere of the Building.—The air supply for the whole interior of the building is filtered, and in winter is also heated.

Output.—The daily output at the time of visit was 130,000 lbs. of milk. The Directors calculate that by the addition of a third bottle washing plant and other three storage tanks, and perhaps another filler, the capacity of the plant could be doubled.

THE NUTRITIVE REQUIREMENTS OF POULTRY.

(*5th Communication.*)

J. B. Orr and M. Moir, Rowett Institute; A. Kinross, West of Scotland College of Agriculture; and G. Scott Robertson, University of Belfast and North of Ireland Department of Agriculture.

SUMMARY OF PREVIOUS PAPERS.

BEFORE dealing with the subject of the present paper it may be of interest to outline briefly the chief experimental results recorded in the previous papers of this series. The experiments referred to in these papers were undertaken to determine whether ordinary well-balanced rations fed to poultry kept under practical conditions were improved by the addition of substances reputed to be rich in vitamins. Tests were carried out with vitamin A "fat-soluble," vitamin B "antineuritic," and vitamin C "antiscorbutic." In these tests cod liver oil was used as a source of vitamin A, yeast of vitamin B and lemon or swede juice as a source of vitamin C.

Vitamin A "fat-soluble."—The tests showed that the addition to the ration of cod liver oil in amounts varying from 1/5th to 5cc. per bird per day was not followed by any increased rate of growth as compared with control pens receiving no cod liver oil. In egg laying tests it was found that from 2 to 5cc. cod liver oil per bird per day did not increase egg production. On the contrary, there was evidence that the use of the oil was followed by a decrease in egg production. These results were obtained with poultry kept under practical conditions and receiving ordinary well-balanced rations such as would be used by a well informed poultry keeper.

In other experiments carried out at the Rowett Institute, where

the birds were kept in strict confinement and fed on certain defective rations, the addition of cod liver oil was followed by beneficial results with regard both to health and rate of growth. It is of interest, in this connection, to note that we have observed that cod liver oil cures or prevents a "roup-like" condition which sometimes occurs in experimental birds suffering from malnutrition.[1]

The conclusion arrived at, as a result of these experiments, is that while cod liver oil has well known therapeutic qualities and may be of value for birds suffering from malnutrition as a result of too close confinement or lack of proper balance of the ration, the routine feeding of this oil to poultry kept under practical conditions with an outside run, and fed with a well-balanced ration, is not beneficial, and indeed may be actually harmful if excessive amounts are given.

Vitamin B "antineuritic."—In tests with yeast, it was found that the addition of yeast to rations which were well-balanced with regard to the known food constituents did not lead to any increased rate of growth in chicks, or increased egg production in full grown birds. It was noted, however, in two of the tests in which the rations used had rather a smaller proportion of protein than the others, that the addition to the mash to the extent of 3 to 5 per cent. of yeast seemed to stimulate early egg production, so that birds began to lay sooner and there was a slight increase in the number of eggs laid between October and January. This, however, was compensated by an equivalent decrease later. As yeast consists almost exclusively of protein and mineral matter, it was thought that the stimulus might be due to the protein, and the results of experiments undertaken at the North of Scotland College of Agriculture seem to indicate that this view is correct.

The conclusion arrived at as a result of these tests is that poultry kept under natural conditions and fed with a well-balanced ration do not need any additional foodstuff as a source of vitamin B.

Vitamin C "antiscorbutic."—Egg is said to contain little or no antiscorbutic vitamin, and in experiments carried out at the Rowett Institute on birds kept under laboratory conditions no beneficial results seemed to follow the addition to the ration of fruit or vegetable juices supposed to be rich in this vitamin. It was considered unnecessary therefore to carry out any tests under practical conditions.

Practical Importance of Vitamins.—The results of these tests seem to indicate that when poultry are kept under good hygienic conditions with a run in the open, and are fed on a ration composed of ordinary foodstuffs and well-balanced with regard to the known food constituents, there is little danger of a vitamin deficiency. There is no evidence to justify the paying of special prices for foodstuffs reputed to be rich in vitamins.

The most important positive result obtained in these tests seemed to be the stimulation to early egg production by yeast when added to certain rations. This appeared to be a result of

[1] An account of this disease has recently been given by Beach (1924), who shows that it can be prevented by the use of cod liver oil, green food or a liberal supply of butter milk and yellow maize.

economic importance which called for further investigation. Work has therefore been carried out on the requirements of the fowl for protein and minerals, the two chief constituents of yeast. The present paper gives an indication of the nature of the results being obtained in practical tests of the value of the addition of a mineral mixture to rations used for laying birds.

Mineral Requirements of Laying Poultry.

For egg production cereal grains and grain offals contain too small a proportion of certain essential mineral elements. Calcium is the element most markedly deficient. An egg, including the shell, contains about 3·04 grams of lime. It would require about 190 ozs. of wheat to yield this amount of lime. Sodium and chlorine are also deficient, though to a less degree. It seems probable that in many grain rations certain other elements may be present in too small amounts. It is not surprising, therefore, that poultry on a ration consisting of cereals consume large amounts of inorganic matter, especially lime-rich substances. It is very probable that the consumption of "grit" is not so much to provide a digestive agent as to supply minerals which are otherwise deficient in the food.

In the last few years several workers have studied the effects of allowing poultry access to minerals or of adding various minerals to the ration. In experiments with pullets kept in hen houses with no access to the ground, Buckner and Martin of the Kentucky Experiment Station (1919) found in a 6 months' test that allowing the animals to have oyster shell or limestone increased egg production over 60 per cent. The addition of grit alone had no effect. At the Ohio Experimental Station, Kennard and White (1922) found that the addition of a mineral mixture of calcium phosphate 60 parts, sodium chloride 20, and calcium carbonate 20 parts, increased egg production more than 40 per cent. These workers suggested that much of the special value of animal proteins as compared with vegetable proteins was due to the former being usually associated with a better mineral mixture, rather than to a difference in the quality of the proteins themselves. Halpin and Hart (1919), of the Wisconsin Experiment Station, found that the iodine content of the food is as important as the calcium content in preventing soft shelled eggs.

The foregoing considerations and the results of the valuable work at Ohio and Kentucky Experimental Stations suggest that poultry rations usually contain too little of certain of the essential mineral elements to provide for the large number of eggs which the modern hen is capable of producing. The poultry experiments recorded in this paper were therefore carried out to ascertain whether the addition to the ration of minerals in which it is liable to be deficient would influence egg production.

Experimental Data.—(A) *The Effect of Adding a Mineral Mixture to the Mash.*—In these experiments an ordinary ration was fed to one pen of birds, which served as the control. A second pen was fed with exactly the same ration plus a certain amount of the following mixture, which was intimately mixed with the mash:—

	Parts.
Calcium Phosphate (Steamed Bone Flour) .	100
Calcium Carbonate (Chalk)	40
Sodium Chloride (Common Salt)	40
Sulphur	10
Ferric Oxide (Oxide of Iron)	10
Potassium Iodide	1

The chief ingredients of this mixture are lime, phosphorus, sodium and chlorine. It was thought that all these might not be present in the ration in sufficient amounts. Sulphur was also added because in certain experiments which we carried out it was found that the addition of sulphur had a marked beneficial effect; some iron was added, as the yolk of egg is rich in iron, and a small amount of potassium iodide was added, as it is believed that it has an influence on the metabolism of lime salts. It will be seen that the above is a purely empirical mineral mixture, not based upon any definite knowledge of the mineral requirements of the laying fowl, which indeed are unknown.

Six experiments of this nature were carried out; the details are given of the three experiments which ran for the longest period.

Experiment I.—(The Rowett Institute.)—In each of the pens there were 14 leghorn pullets hatched 15/5/23. The birds had a run on rough pasture of an area of 250 square yards per pen, with access to oyster shell and flint grit.

The ration consisted of:—

Mash.	*Parts.*	*Grain.*	
Wheat Offal .	8	Wheat	Equal parts.
Ground Maize .	3	Oats	
Crushed Oats .	3	Kibbled Maize	
Bean Meal . .	2		

The mineral mixture was added to the mash of the experimental pen in the proportion of one of salt mixture to twenty of mash. The experiment was continued for twelve months. The following table gives the average egg production per pullet for each month of the year:—

	Control Pen.		*Experimental Pen. (Minerals in Mash.)*	
	Av. No. of eggs per bird.	Av. Wt. gms.	Av. No. of eggs per bird.	Av. Wt. gms.
Oct. .	...	...	·2	62·1
Nov. .	1·8	47·73	5·6	52·5
Dec. .	8·5	55·7	20·8	55·2
Jan. .	7·0	57·9	17·8	56·1
Feb. .	11·3	60·4	16·3	57·9
Mar. .	16·1	64·4	20·9	58·6
April .	14·0	58·7	19·6	57·4
May .	14·2	60·5	19·9	58·0
June .	9·8	61·5	14·2	60·3
July .	9·0	59·0	15·2	59·8
Aug. .	8·0	62·2	14·3	58·9
Sept. .	7·7	61·4	13·2	62·4
	107·4	60·1	178·0	58·0

Experiment II.—(Kilmarnock.)—Each pen contained 12 white leghorn pullets, hatched 27/4/24. The pullets had a run on pasture with access to oyster shell. The ration consisted of:—

Mash.	*Parts.*	*Grain.*	
Wheat Offal	10	Oats	Equal parts.
Maize Meal	7	Wheat	
Oatmeal	5	Maize	
Blood Meal	5*		

* On 23rd October proportion of blood meal was reduced from 5 to 2·5 parts.

The mineral mixture was added to the mash of the experimental pen to the extent of one part mineral mixture to twenty parts mash. The following table shows the average egg production per bird for each month:—

	Control Pen. Av. No. of eggs per bird.	*Experimental Pen. (Minerals in Mash.)* Av. No. of eggs per bird.
September	·92	1·0
October	1·67	6·08
November	6·50	11·92*
December	15·67	18·00
January	13·08	13·08
February	12·67	13·83
March (to 28th)	10·71	19·75
	61·22	83·66

* Including 37 eggs (*i.e.* an average of 3·1 per bird) of less than 1 ounce. All these were laid by two birds.

Experiment III.—(Belfast.)—Each pen contained eight pullets. They had a run on pasture with access to oyster shell. The ration consisted of:—

Mash.	*Parts.*	*Grain.*	
Wheat Offal	6	Oats	Equal parts.
Maize Meal	2	Maize	
S.G. Oats	1		

To the mash of the experimental pen the salt mixture was added in the proportion of one part of salt mixture to fifty parts of mash. The following table shows the average egg production per bird for each month:—

	Control Pen. Av. No. of eggs per bird.	*Experimental Pen (Minerals in Mash.)* Av. No. of eggs per bird.
November	5·1	6·3
December	6·9	7·8
January	14·3	14·8
February	12·3	17·0
March	15·0	21·9
	53·6	67·8

It will be seen that in each experiment the addition of the mineral mixture to the mash is accompanied by a distinct increase in the number of eggs laid per bird. In Experiment I., which ran for twelve months, the increase is about 70 per cent.; in Experiment II., which ran for seven months, the increase is about 35 per cent.; in Experiment III., which ran for five months, the increase is about 25 per cent. In three other experiments for shorter periods of four or five months, increases of 5 to 20 per cent. were obtained in the experimental groups. While there seems to be a definite stimulation to egg production at the beginning of the laying period, the influence of the addition of the minerals appears to be even more evident towards the end of the laying period.

(B) *The Value of the Mineral Matter in Fish Meal.*—Fish meal contains 15 to 25 per cent. of mineral matter, consisting chiefly of calcium, phosphorus, sodium and chlorine. It is also rich in iodine. These are the elements most likely to be deficient in the rations of laying birds. It was thought, therefore, that some of the value of fish meal might be due to the mineral matter which it contains, and some tests were undertaken to determine the relative value of rations containing fish meal, and similar rations without fish meal but containing a mineral mixture. Some of the tests were carried out in conjunction with those recorded above. To give an idea of the nature of the results being obtained, figures are given for two of these experiments.

Experiment IV.—(The Rowett Institute.)—In this test the ration and mineral mixture used were as recorded in Experiment I. In a third pen fish meal was substituted for an equal weight of bean meal. The rations for the three pens were thus as follows:—pen 1, ration only; pen 2, ration plus mineral mixture; pen 3, ration with fish meal substituted for bean meal and no extra mineral mixture. Each pen had fourteen pullets, and the conditions with regard to accommodation and access to oyster shell were as stated in Experiment I. The egg production per bird for a test of twelve months was as follows:—

Ration only.	*Ration plus Mineral Mixture.*	*Ration with Fish Meal substituted for Bean Meal.*
107·4	178·0	154·8

Experiment V.—(West of Scotland College of Agriculture.)—This test was of the same nature as Experiment IV. There were twelve pullets in each pen, and the ration and conditions were as recorded for Experiment II. In the ration fed to the third pen, fish meal was substituted for blood meal in the basal ration in the proportion of six parts of fish meal to five parts of blood meal. The egg production per bird for a test during seven winter months was as follows:—

Ration only.	*Ration plus Mineral Mixture.*	*Ration with Fish Meal substituted for Blood Meal.*
61·2	83·7	93·7

In other two tests of a somewhat similar nature, which have run for five months, the results are in accordance with those of Experiment V.

In all these tests the ration with either fish meal or a mineral mixture is distinctly better for egg production than the ration with neither of these additions. The results suggest that the well-known value of fish meal for egg production is due partly to the mineral matter which it contains. The data presented here are far too limited to justify any conclusions as to the relative values of the empirical mineral mixture used in these tests and of that found in fish meal, nor indeed is that a matter of any importance, as the mineral mixture being used in these tests will be gradually modified, and, it is hoped, improved, as more knowledge is obtained.

Conclusions. — The results recorded above show the great practical importance of the mineral content of the ration of laying poultry. It is a remarkable fact that even in cases where the birds have an outside run with free and continual access both to green food and to lime or oyster shell from which they can supplement the minerals in the food, they are still liable to suffer from a deficiency of certain minerals, and the addition of these minerals to the mash leads to a definite increased egg production. The conclusion of practical importance would seem to be that the addition to the mash of a mineral mixture of something of the nature of that used above, or of some food such as fish meal which contains a very large proportion of mineral matter, will lead to increased egg production.

It should be noted that the mineral mixture used in these experiments is an empirical mixture intended to serve merely as a starting point for practical tests. In the light of tests at present running, it will doubtless be altered with a view to its improvement. When work which is being carried out at Cambridge to determine the exact mineral requirements of hens is completed, we will have information which will be a guide in compounding rations containing approximately the right amounts of all the different essential minerals.

REFERENCES.

1. Previous Papers :—
Scottish Journal of Agriculture, 6, 349, 1923.
Do. do. 7, 264, 1924.
Do. do. 8, 62, 1925.
Do. do. 8, 66, 1925.
2. Beach, Bull. 378, Coll. of Agriculture, California, 1924.
3. Buckner and Martin, J. Biol. Chem., 41, 195, 1919.
4. Kennard and White, Bull. Ohio Agric. Exper. Station, 7, 171, 1924.
5. Halpin and Hart, Bull. Wisconsin Agric. Exper. Station, 382, 32, 1919.

RESEARCH IN DAIRYING.

R. STENHOUSE WILLIAMS, M.B., D.Sc., D.P.H., etc.,
The National Institute for Research in Dairying, University College, Reading.

REALISING, as one must, that the great object of a dairy herd is to produce the maximum quantity of milk of good quality and free from disease, it would be possible to initiate the work of a research institute in dairying by a complete study of the

conditions which lead up to the production of quantity and quality of milk.

With these ends in view it would be necessary to study the physiology of milk secretion and the exact effects upon the constitution of the cow of the different elements found in food stuffs. The influences of the land and of different methods of cultivation upon the composition of food stuffs would be a natural corollary to this work.

An Institute founded upon the basis which has been outlined might easily fail, not because the idea was not perfectly sound nor because those within the Institute were not carrying out work of the greatest possible importance, but simply by virtue of the fact that, for a long time, they might have nothing to offer which was of immediate concern to the industry, and those who did not understand the immense complexity of the problems involved might lose heart and allow the project to lapse. Is there any other procedure which might be adopted? It would seem that there may be, for if the origin of the Pasteur Institute or of the Schools of Tropical Medicine be considered, it is found that these depended upon the solution of some difficulty which was a constantly recurring curse to some great group of the people of the country concerned.

Pasteur, working in a cellar in Paris, solved a problem which was bringing the wine industry of France to ruin, and in so doing set a light which has shone in the dark places of the earth, saving not only the industry with which he was immediately concerned, but also revolutionising the methods of treatment of disease.

On the one hand, his work, by demonstrating that the faults of the wine industry were due to the action of specific living cells which need not have been present, made possible the whole development of modern surgery and rescued our hospitals from the appalling record of septic infection of wounds which existed almost within the recollection of living men.

On the other hand, that work, with that of many others, showed the specific nature of infection, that it depended upon a definite type of living cell, which, by its growth and multiplication, gave birth to the evil effects. The application of these results to the study of diseases has made it possible to discover their exact nature and the proper methods to be adopted for their elimination or avoidance. Thus it is that cholera and plague do not invade our country, and typhoid has been so reduced in extent that our death-rate from this disease is perhaps the lowest of any great country in the world. Thus it was that the death-rate from disease on the Western Front was the lowest ever known in the history of war. Thus it is that the child born in our country to-day may expect to live twelve years longer than his grandfather. No one can measure the increased efficiency which this fact involves.

Such are the beginnings of research and such are some of the amazing results which it may attain. It may be noted that the beginning is relatively small, the origin of the work being the investigation and solution of the problems involved in some serious defect which is of common occurrence in the industry; the ultimate

result does not exist, for it is an ever-growing tide of benefit which is beyond the conception of the imagination.

What is now known as the National Institute for Research in Dairying was started by the Development Commissioners and the Ministry of Agriculture in 1912. In its early days the staff consisted of a chemist, a bacteriologist, a laboratory attendant and a boy. Its total income was £1500 a year, out of which all expenses had to be paid. It was housed in primitive laboratories in the town of Reading, and did not possess a farm or a dairy under its own control. At the present time its staff consists of about 52 persons. It has an experimental farm of more than 300 acres, an experimental dairy and laboratories, which are fitting for the work which is to be done.

It may be well to consider upon what basis this growth has been built up. It has been built up by virtue of the fact that the Institute has been fortunate in its friends, and the friends arose because the Institute was able to give help in problems which were causing serious loss to the industry. How then did the staff find these problems and whither are they leading?

When the Institute was first started no specific plan of work was laid down for its initial staff. This was a very wise procedure, for it left the members with free hands to work out their own salvation. It is true that in the early days the members felt that they had no very tangible facts upon which to base any definite line of research, as the position was such that accurate statistics concerning losses and causes of loss within the industry were not available. It was decided, therefore, to take up such work as was immediately available and see how it would develop.

One of the most immediate problems which was brought to the attention of the staff was that of discoloration in Stilton cheese; a problem of great complexity upon which members of the staff are still working, and one which, after all, concerns but a small fraction of the milk industry. Nevertheless, the solution of one aspect of this problem led to events of great import both to the industry and to the Institute, for it was demonstrated that the fundamental cause of this fault was the dirty condition of the original milk. In the course of time the work of the Institute developed and further problems were brought to the notice of the staff. It then became evident that lack of cleanliness of milk was a source of serious loss to many branches of the industry.

During this time also the Institute was attracting friends, with the result that, in the year 1916, a Committee was formed to help to promote its work. That Committee at once realised the necessity for further enquiry concerning losses and causes of loss, particularly in the whole milk trade. Such an enquiry was instituted and revealed the fact that lack of cleanliness in milk was a grave source of monetary loss to the industry, both directly, as milk was sour on delivery, and indirectly, because of the necessity of pasteurising much milk which might otherwise have been delivered in the fresh state. The Committee felt also that the existence of such milk must operate very unfavourably upon the sale of milk and be a cause of the low consumption of milk which is found in this country. The suggestion of the staff that a

thorough study of the methods of handling milk should be carried out was therefore approved.

At one time some thought that such an investigation was not a matter for research. This view was generally taken for three reasons. First, the state of cleanliness of milk was a matter affecting public health and, therefore, a problem which should be investigated by the medical fraternity. It was not realised that the condition of milk and milk products as they reach the consumer is the life blood of the industry upon which its whole success must depend. Further, the studies concerning the handling of milk which were carried out, chiefly by Delepine, Orr and Savage, were never generally applied in the industry, mainly because such work was being carried out by men who were not within the industry itself. Second, we all think that cleanliness is something which we all understand, and third, the problem had already been worked out in other countries and it was only necessary to adopt the results obtained. As a fact, cleanliness is not understood in the sense in which it must be understood if the handling of milk is to be brought to a successful issue, and the problem has by no means been solved by other countries. It appears so simple that it is difficult, save for those who have really studied this problem, to realise how much work requires to be done, and will require to be done for a long time to come, before the many obstacles which arise can be overcome. In any event the work must be adapted to the conditions of the country in which it is being done that it may be made an economic proposition. It must further take into account the times of haulage of the milk, temperature conditions, and the state of the Public Health Administration, all of which vary in different countries.

In the early days the study of the methods of handling milk was carried out at a farm which was not under the control of the staff of the Institute, and it was found that, although those on the farm were willing to give all the help that they could, it was not possible to carry out the investigations under continuous conditions and with labour of the required quality. This work was continued for several years, and the longer it went on the clearer it became that a dairy farm under the control of the staff of the Institute was essential if satisfactory progress was to be made. This, then, was one result which was attained by the study of the problem of discoloration in Stilton cheese. The staff of the Institute obtained a dairy farm as well as laboratories, and the work carried out therein is bringing precise knowledge to bear upon the problems of the whole milk industries. There was, however, at least one other result, since the study of this problem of the cheese industry demonstrated also that its proper solution necessitated, not only a dairy farm, but also a dairy under the control of the staff of the Institute.

It has been stated that it was found that the discoloration in the cheese was due to dirt organisms in the milk. It would have been possible to go down to the factories on which these cheeses were being made and tell those who were responsible for the work of cheesemaking that if they cleaned up the milk they would be free from discoloration. It would have been an extremely

foolish thing to do, as nobody knows all the factors which are involved in the ripening of a Stilton cheese, and it may be that some of the organisms which are present in milk which is not clean are responsible for a share in the ripening; or it may be that the discoloring organisms themselves assist the ripening under one set of conditions, although producing a fault under another set of conditions. It was, therefore, quite possible that such advice would lead only to disaster, since the cheese maker, while eliminating discoloration, might altogether fail to produce Stilton cheese. Other advice, therefore, based upon observations which had been made in the course of the work in the laboratory, but of a palliative nature, was given, and it is comforting to know that it has proved satisfactory, but there still remains the danger that it may break down, since it does not eliminate the cause of the trouble, but only hides its existence.

It is clear that a Research Institute must not rest satisfied with such a solution, but must continue its work until it has established the exact conditions for successful cheese making. In order that such work may be accomplished it is necessary to know the exact nature of the organism or organisms which are producing the change and the exact nature of the conditions under which they work. Bacteriologists, mycologists, chemists, dairy workers and other scientists of highly trained capacity are, therefore, required, since the work is of great complexity involving the study of the life histories of many varieties of organisms, in some cases also of their inter-action one upon another and of the exact chemical changes which are produced by their introduction into milk in the process of cheese making. In the National Institute for Research in Dairying a prolonged series of scientific investigations into the problem of discoloration in Stilton cheese has, therefore, been carried out. The members of the staff have long known that this work must eventually be carried down into the dairy, and that the effects of various types of organisms upon milk produced under controlled conditions, which is being converted into cheese also under controlled conditions, must be studied. They realise that, if any error should creep in, either in the handling of the milk in the cowshed or in its conversion into cheese, their results may lead the industry astray, a disaster which they hope to avoid. The necessity for a dairy is thus made clear.

But this is far from being the end of the story—probably there is no end—but for the moment it may suffice to envisage the future as it is seen by the members of the staff of this Institute. If a Research Institute in Dairying is to fulfil its duties adequately, it must study not only the methods of handling milk and milk products, but must also be prepared to undertake investigations concerning the economic production of milk, and in that relationship must investigate two rather different but intimately connected kinds of problems. It must be prepared to consider which of the many methods that may be adopted for the feeding of dairy stock is the most efficient and economical under varying conditions. Such work has already proved to be of the greatest value in assisting the farmer to reduce his costs of production and, at the same time, to increase the quantity of milk which the cows

give, but it cannot possibly rest there, and must eventually lead to a complete study of all those factors which influence the economical production of milk of good quality. In the case of this Institute the necessity for such work has been brought home to us in a variety of different ways. There was the obvious need for investigations into the reasons which cause different breeds of cows to give milk of different constitution Some time ago, also, a member of the staff was asked to consider the value of stored whey in comparison with fresh whey as a food stuff. This work was undertaken and has developed into a study of the influence of accessory food factors upon the health of animals. This study is not only of great value to agriculturists, but is of almost equal interest to those who are concerned with human nutrition. Thus, out of a question which was certainly not intended to be one of great magnitude, is developing work of the highest importance. On the one hand it leads up to the consideration of the true values of different types of feeding stuffs, and on the other to the consideration of the land from which these food stuffs are obtained. Why is it that one parcel of land appears to provide a better food stuff than can be obtained from other land, even on the same farm? Why is it that a practical farmer puts his stock on particular fields if he wishes to obtain the best results? There is a vast field for study here, much of which cannot yet be undertaken by the staff of the National Institute for Research in Dairying Nonetheless it will come in time, and when it does the dairy farmer will be able to breed and feed with sure knowledge of what he is doing. Milk recording societies, bull societies, improved methods of handling of milk and the greater interest taken in agricultural education are all leading the way to the recognition of the fact that dairying is a branch of applied science of infinite value to the nation.

In the meantime there are many directions in which it is found possible to give assistance to those who are concerned with the milk industry. The causes of many faults, such as ropy milk, blown tins of condensed milk, oily milk, etc., etc., have been discovered Some of these are sources of grave loss to the industry. It is true that in many instances all the possible sources of these troubles have not yet been investigated, but the specific causes have been found and the way cleared for further work. The study of the problem of bovine tuberculosis has made it possible to demonstrate to the dairy farmer the great value of the tuberculin test in freeing his herd from disease. It is good that such work should be done in an institute of this character, because it then comes from those who are directly interested in agriculture, and is brought home to the farmer in a way that is not possible when it is carried out in an institute which is not directly concerned with dairying. It is also found that very valuable help can be given to those who are responsible for the making of different types of dairy machinery. In the past much dairy machinery has been made by those who were considering the problem only from the point of view of the engineer, with the result that it is not really suited to the work that it is intended to do. Such problems are considered at the National Institute for Research in Dairying, and

an increasing number of dairy machinery makers are applying to that Institute for assistance of this character. It is not found necessary to employ a special engineering staff for this work since the assistance of the Research Institute in Engineering at Oxford can be obtained for the engineering aspects of the problems.

It is not uncommon for research institutes to find a certain difficulty in spreading the knowledge which has been obtained. That difficulty has not arisen to any great extent at the National Institute for Research in Dairying, partly by virtue of the fact that the Ministry of Agriculture has made provision for lectures, etc. by members of research staffs throughout the country, partly because the Ministry originated a special annual course, which has been held at the Institute now for several years, and is attended by a number of those who are anxious to promote the best interests of dairying. In addition the staff of the Institute work in close collaboration with the British Dairy Institute. Its members are also represented upon most of those bodies which are concerned with dairy progress, such as the Royal Agricultural Society of England, the British Dairy Farmers' Association, the National Milk Publicity Council and the Agricultural Education Association. Further, they give help and advice to great numbers of those who are actually engaged in the work of producing or handling milk, and undertake the examination of many samples on their behalf. Numbers of leaflets which are designed to be of practical utility are issued every year.

It is hoped that it has been made clear that the development of the National Institute for Research in Dairying was based primarily upon the solution of problems of fundamental importance to the industry.

The fact has been kept in view that the ultimate object of the Institute is to enable the dairy farmer to produce the best milk from the best cows, with all that this involves—the study of the land, of crops and of breeding for dairy purposes. Further, it has not been forgotten that all this work would be incomplete if it were not realised that the success of milk production must depend upon the successful sale of milk and milk products. Every attempt, therefore, is being made to assist those who are concerned with the sale of milk or the preparation of milk products, and also those who are responsible for the making of dairy machinery.

The immediate work of the Institute is controlled by the Professional Committee, the exact constitution of which has not yet been finally settled, as the Institute grows rapidly, and it appeared inadvisable to adopt too rigid a constitution early in its career. The important points about this Committee are, first, that not only the Institute's staff are represented on it, but also members of the College staff, who render invaluable help and secure constant intimacy between the Institute and the College; and second, that the Chairman is elected by his colleagues. There is nothing new in this arrangement, it is simply an application of the Faculty system which is common in most universities. It was adopted in the belief that mutual collaboration would, in the end, give the best results, and in order to prevent the somewhat heartbreaking

experiences which have been known to occur under other systems of government.

It is more than likely that such a system is impossible in an institute which is isolated. Some would regard that as a very serious argument in favour of establishing such an institute at a larger centre. There are also other considerations which seem to lead in the same direction. It has already been stated that the advice and help of colleagues, other than those on the immediate staff of the Institute, are found to be invaluable to the Professional Committee. In addition, problems arise the solution of which requires workers of types not to be found on the Institute's staff. Such workers are not infrequently found on the College staff, and the problems are then referred to them, to the great advantage of the milk industry.

THE BIOLOGIST ON THE FARM.—No. XVIII.

Professor J. ARTHUR THOMSON, M.A., LL.D.,
University of Aberdeen.

Pigeons without Reproductive Organs.—Professor Oscar Riddle reports on sixteen cases of pigeons without a discoverable trace of reproductive organs or gonads. It is practically certain that this absence of gonads was complete and persistent—not a temporary condition nor one that set in shortly before the examination of the birds. It was probably due to some physiological disturbance in development. Riddle suggests that something occurred that prevented the primordial germ-cells reaching the proper place (the germinal ridge) for development into reproductive organs.

"Despite the complete and persistent absence of testicular tissue, some of these birds developed complete and emphatic masculine behaviour; some additional secondary sex characters observable in these forms were likewise developed to one or another degree." This is remarkable, for one of the outstanding results of twentieth century inquiry into the physiology of sex has been the proof that hormones liberated into the blood by endocrinal tissue in the reproductive organs serve to pull the trigger of certain activities or to prompt the development of certain structures. The antlers of the stag will not grow without the stimulus of the testicular hormone. The duck without its ovary puts on the complete plumage of the drake. But in Riddle's cases it seems that what is normally accomplished with the aid of the testicular secretion (or "incretion," as he calls it) may also be accomplished without it. This suggests to Riddle that the hormones of the gonads may be "controlled" as well as controlling factors in sex development. That is to say, there may be something even more fundamental than the establishment of an ovary or testes, something even more fundamental than the chromosomal or genetic sex factors. Perhaps the fundamental peculiarity, which might evoke secondary sex characters in an animal without gonads, is a peculiarity in the rate or level of metabolism. Perhaps maleness

and femaleness mean fundamentally a difference in what we might call protoplasmic "gearing," the rate of anabolism and katabolism and the ratio between them. And so we come back to the physiological theory of sex promulgated by Geddes and Thomson in their "Evolution of Sex" which was published in 1889!

A Queer Creature.—Every now and then one is pulled up by the queerness of some living creature. It may be a queerness in bodily architecture: take a bat for instance. It may be a queerness in life-history: take a liver-fluke for instance. Or it may be a queerness of behaviour; and a good example will be found in the habits of an American grub, the young of the Green June Beetle or Fig-Eater (*Cotinis nitida*), which has been recently studied by Miss Anna Laura Hintze (Annals of the Entomological Society of America, 1925, vol. xviii.). The grub is of considerable agricultural importance, for it is fond of potatoes, turnips, carrots and the like. It makes burrows in the ground, but it wanders about on the surface at night. Its constitution seems to be wound up to alternate between burrowing and emergence, for experiment proved that its coming up did not depend primarily on such conditions as dampness, darkness, temperature or food-supply. But the peculiar feature is that it moves about on its back, both when it is on the surface and when it is underground. By waves of contraction passing along its back it wriggles along on the ground with its legs waving uselessly in the air. If it is turned on to what one might call its natural position, it brings its two ends together, falls over on its side, and then gets on to its back again. This is a strange habit and yet it seems to work well. On the surface a rate of about two feet per minute was observed, and the average was rather over a foot and a half. In shallow soil the maximum was about an inch and a half in a minute but the locomotion was not quite continuous.

How can one explain the habit of wriggling along on the back instead of using the three pairs of legs? Perhaps the answer is to be found in the fact that the legs are used to assist the jaws in digging. They grip into the soil and throw it along the upturned ventral surface. The numerous ventral bristles push upon the upper wall of the burrow when the dorsal muscles jerk the body along. It may be then that the legs are not used for locomotion because they are of more use in burrowing. When all is said, however, it remains a queer thing that a grub should move along upside down. We do not know of any other grub with this peculiarity.

Rhinoceros Mice.—A diagrammatic instance of what is meant by a mutation may be found in the occasional appearance of hairless mice. A mutation is an abrupt new departure that is not connected by intergrades with the normal form. It is a discontinuous variation or freak. Mutational hairlessness is occasionally illustrated in the genus Mus—the common mice and rats; and Professor F. B. Sumner has recently given an interesting account of its occurrence in the American white-footed mouse or deer mouse, technically called Peromyscus. The mutants have the juvenile coat of hair, but it begins to fall out at the age of about two weeks. The falling out continues for a few weeks till it

is practically complete except that the sensitive whisker-hairs or vibrissæ and the eyebrow hairs always persist. There is a remarkable elongation of the claws and an exceptional development of folds on the skin. These corrugations are sometimes so deep that they blind the animal! It is to the corrugated appearance of the skin that the popular name "Rhinoceros Mouse" refers. Is it not strange, in a way, that the almost complete disappearance of the hair, which looks like a *minus* integumentary character, should be associated with very long claws and with corrugated skin, which look like *plus* integumentary characters. Atrophy and hypertrophy together!

It must not be thought that the hairlessness is an individual disease in the ordinary sense, for some of the hairless white-footed mice which Professor Sumner studied had lived for a year. Moreover the peculiarity is hereditary. It may be granted, however, that the hairlessness is associated with enfeebled constitution and with a high percentage of sterility, especially on the female side.

A hairless condition sometimes occurs in young pigs, and this is believed to be due to deficient functioning on the part of the sow's thyroid gland. Such hairless pigs soon die, if indeed they are not born dead. As it was found that the birth of hairless young pigs stopped when the mother sow got small doses of potassium iodide with its food for some time before the birth of the litter, the same treatment was tried with the parents of the hairless mice. But there was not the slightest effect. Nor did iodine treatment of the young mice make any difference. So what is sauce for the pig is not sauce for the mouse. Or it might be safer to notice that we cannot assert that the hairlessness of the pig is of the same nature as the hairlessness of the mouse. Personally, we should think that the former is modificational and the latter variational.

The hairless mutation occurred in two unrelated series of white-footed mouse, and on one of the lines fifty-two hairless individuals occurred. On the whole, though the numbers are not large, it seems justifiable to call the hairlessness a recessive Mendelian character. That is to say the offspring of a hairless individual mated with a normal individual will be all normal. But when these offspring are paired with one another there will be about 25 per cent. hairless mice in the litters. As a matter of fact the numbers Professor Sumner got were rather divergent from the typical Mendelian ratios, but the important fact is the appearance of the clear-cut hairless type in the inbred grandchildren of a hairless and normal mouse.

An Interesting Duplicity.—We have received one of those extraordinary double creatures or duplicities which occasionally crop up. It was a double chick that could not hatch out. There was one head and a somewhat double neck with the two imperfectly finished backbones in contact with one another. Then came what seemed to be two breastbones, but the preservation was bad and the parts were still very delicate. Each side had a pair of wings. Each side had also a distinct hip girdle with a pair of legs. So there were altogether four wings and four legs. What

does this sort of thing mean? It means that the delicate embryonic disc lying on the top of the yolk is partly divided into two at an early stage, each half developing on its own account. A perfect division into two would result in "identical twins." A very slight division would result in, say, an extra pair of hind legs. Between the one extreme of twins (from one egg) and the other extreme of nothing more than the development of a supernumerary limb there is every possible gradation. But what could bring about the division of the embryonic disc or blastoderm into two? There seem to be two main causes. Some mechanical influence, such as might follow from a tumble, may split the delicate disc into two. Or some disturbance of the chemical routine (metabolism) within the developing egg may set up processes which dislocate the disc. Along a particular line there may be a solution of cells or a deadening of cells, and the result is a duplicity. There may be two heads and one body, or, as in this case, two bodies and one head.

Animal Nutrition.—Could one not fatten stock on waste paper? This question is suggested by Dr. L. R. Cleveland's success in rearing white ants or termites on a diet of pure cellulose. As a matter of fact they fed on Whatman filter paper which had been extracted in hydrochloric and hydrofluoric acids and in ether. More than 10,000 termites of two different species were used in the experiments, and they grew and multiplied for eighteen months without the slightest sign of malnutrition. Growth and multiplication occurred with the same rapidity as in the controls that received their normal diet of wood. Some of the colonies that were started with ten adults had after eighteen months more than two hundred half-grown individuals. The weight had increased forty times on a diet of filter paper!

Many herbivores feed mainly on carbohydrates, such as sugar, but that is very different from a diet of pure cellulose. There are many extras in the herbivore's diet of grass or clover. Yet the herbivores do utilise much cellulose, and in doing so they seem to be indispensably helped by Bacteria and Infusorians in their food-canal. It is therefore interesting to notice that all the wood-eating Termites that have been examined contain an abundance of intestinal Infusorians (of remarkable beauty, like those in a horse's stomach), which have been proved to help in the utilisation of the dryasdust food. Similarly in many wood-eating insects, like the lesser deathwatch or bookworm, there are partner yeast-plants which seem to have a fermentative action on the contents of the food-canal. Many cases are now known of this kind of vital partnership or symbiosis, but we should like to hear more about growing fat on filter paper.

Awakening of the Ground-Squirrel.—This is not a very appropriate time of year for thinking about hibernation, and yet one must remember that summer sleep or æstivation, which sets in during great heat in some animals, is just the same kind of phenomenon as winter sleep. In both cases we have to do with an old established life-saving reaction that a mammal with some imperfection in its warm-bloodedness makes to extreme temperature conditions. The relapse into a state more reptile-like than

mammalian is very striking, and not less striking is the process of re-awakening. This has been recently studied by Professor George Edwin Johnson of the Kansas Agricultural College, the creature studied being the American Ground Squirrel (*Citellus tridecimlineatus*). The awakening from hibernation in this rodent is almost violent. The body temperature may rise from 2° C. to above 30° C. Inspirations may increase from one per minute to about 150 per minute. The pulse-rate may rise from 13·5 beats per minute to about 300 per minute. These changes are almost terrific, and one is not surprised to learn that they normally require about an hour when the hibernator is very torpid. The intensity of metabolism increases slowly at first and then very rapidly as the time of awakening is approached. It is interesting to find that the anterior part of the body recovers from the peculiar state of lethargy earlier than the posterior regions, and that the total period of wakening may be shortened by transferring the torpid animal to a warm room. At last the squirrel opens its eyes. It is awake; a warm-blooded animal once more!

Eyes and no Eyes.—How does an earthworm know when it is time to come out of its burrow, for it has no eyes? In the strict sense, perhaps, it does not know anything; therefore our question becomes how does it sense the difference between light and darkness? The earthworm is constitutionally a light-shy animal, or, as learned people say, negatively heliotropic. Those earthworms that we see above ground during the day are out of health, or drowned out of their burrows, or parasitised by some fly. But let us keep to our question: how is the earthworm made aware of differences of light and shade. It is a familiar fact that there are numerous sensory nerve-cells in the earthworm's skin which send tidings of various kinds from the outer world to the nerve cord. But Dr. Walter N. Hess has found a special kind of superficial cell which is sensitive to light. It does not seem to have been noticed before, though hundreds of zoological students are studying microscopic sections of earthworms every year. Each of these special cells, according to Dr. Hess, has a central glassy body like a miniature lens, and this is surrounded by a network of nerve-fibrils which will act like a little retina. These cells are most abundant in those parts of the earthworm's skin that are most sensitive to light. They are absent from the under surface of the rings except at the two ends of the body. Similar "photo-receptors" are well known in leeches, which are exquisitely sensitive to light and shade.

People often wonder how such a marvellous organ as the human eye could possibly be evolved, but they are apt to forget the very simple beginnings of eyes that occur in such animals as leeches, and the long flight of steps on which we might arrange a hundred and one kinds of eyes of gradually increasing complexity. Not of course that all eyes are on one and the same line of evolution, for the compound eye of a lobster or a butterfly, with hundreds of lenses, is on a plan entirely different from the eye of ordinary backboned animals. At the same time it is possible to make a long series of one-lensed eyes of gradually increasing complexity. It is, in any case, important to keep in mind the

interesting fact that before the eye became in the course of ages a seeing eye, able to form an image, it was a structure for distinguishing between light and darkness; and that is the level represented by these scattered "photo-receptors" of the earthworm. Similarly, before the ear became in the course of ages a hearing ear, it was a balancing organ, as it continues to be. And before the brain became a thinking organ, it was the organ for controlling muscular movements.

Bees and Garlic.—Lieut.-Colonel C. Samman and Professor J. Brontë Gatenby, working from the Zoological Department of Trinity College, Dublin, have been experimenting with bees infected with acarine or Isle of Wight disease, now well-known to be associated with the presence of mites (*Acarapis woodi*) in the tracheæ. They have got some good results by treating the infected bees with candy sugar containing a percentage of garlic juice (*Succus Allii*). Garlic can easily be grown by bee-keepers, the bulbs can be dug up, and the juice expressed and mixed up to a strength of 15 per cent. with sugar. The treatment should be tried in the winter months when the bees are clustered.

From China to Peru.—It may seem at first sight that the biologist on the farm cannot have much right to speak about the islands of Peru, but that is just where you are wrong, dear reader, as they used to say. For what is a farm without manure, and what is the best of all manures but guano, and what is the best guano but the urinary excretion of the gannets and pelicans and cormorants that breed on the Bird-islands off the Peruvian coast. In one island there are said to be over five million birds, requiring a daily consumption of a thousand tons of fish! Dr. R. C. Murphy has recently written a very interesting and reliable book entitled "Bird Islands of Peru" (Putnams, 1925), and he explains the Natural History of guano. It seems that the islands in question are washed by "Humboldt's current," a beneficent sweep of cool water which brings about a prolific abundance of marine life. There is a thick sea-soup of Diatoms and Infusorians; these are reincarnated in myriads of small crustaceans, which form the staple food of surface-swimming fishes, such as anchovies. Now it is the abundance of these fishes that accounts for the multitudinousness of the birds that make the vast accumulations of nitrogenous waste-products on the rocks. These waste-products are filtered out from the kidneys, and the urine of birds is, as everyone knows, semi-solid. In a dry climate this is not washed away or much changed by atmospheric influences. So it accumulates year after year and the result is a priceless guano-bed.

They say that guano is thirty-three times more effective than farmyard manure as a fertiliser. This is partly because it is so rich in nitrogenous compounds, and partly because these are in a form that makes them very readily absorbed as food by the roots of plants. We need not pursue the matter further, it is plain that guano spells bread. The cheering piece of news is that there is being enforced a well-thought-out system of rotation in guano-collecting. Each island is being allowed a periodic rest. When the removal of the guano is unsystematic and the disturbance of the nests is ruthless, then the colonies dwindle and the supply of

guano comes to an end. But on the new scheme, based on commonsense and science, guano will go on for ever. And so we pass from China to Peru, or at any rate from our hungry farm to the guano islands.

TRACTOR COSTS, 1923-24, ON A FARM IN EAST KENT.

H. W. KERSEY AND D. BROWN.

IN these days the tractor plays an important part in the economical management of the farm. On farms where there is a considerable acreage under the plough, there is no doubt that the use of a tractor may effect a considerable saving in expenditure when compared with horse labour, especially if the work is arranged in such a way as to keep the tractor in regular employment throughout the year.

In addition to ploughing and other cultivations on the arable land, there is a variety of other work on the farm which can well be done by the tractor. Grass land may be rolled and harrowed (in a single operation), corn may be cut by means of the simple attachment of a special draw-bar to the binder, chaff-cutting and corn-grinding can be done during the winter months and also threshing, provided that the farmer has sufficient capital and a large enough acreage of corn to make the purchase of a threshing machine and elevator worth his while.

With regard to the last named operation, not only will the threshing be cheaper per quarter than with a hired outfit, but there is always the great advantage of being able to thresh at such times as suit the farmer best and when it is often difficult to find work for the men, as for example during the months of December and January.

A further advantage of the use of the tractor, which cannot be estimated in money value, is that work can be done quickly and expeditiously at certain seasons of the year when the land is working well, and when it is essential to take full advantage of the weather. Considerably more ground can be covered by a tractor than by horse power in a given time.

So far as the cost of the running of the tractor is concerned, one of the heaviest items of expenditure is depreciation. The life of a tractor will not exceed five or six years, and if it is in use for a short time only during the year, the depreciation is so high as to make the operation more expensive than if carried out by horse labour. If, however, the tractor is regularly employed, depreciation is spread over a number of different operations and over a greater acreage, and although renewals and repairs would be greater when the machine is in constant use, the cost per acre or per quarter for depreciation would be much less. Therefore, in order to run the tractor economically, the owner should provide as much work for it as possible throughout the year.

The following is a summary of the work carried out during the year ending Michaelmas 1924 with a Fordson tractor:—

TABLE I.

Summary.

	Acres.	Acres per day.	Tractor only. Cost per day.	Tractor only. Cost per acre.	Tractor and Driver. Cost per day.	Tractor and Driver. Cost per acre.
			£ s. d.	s. d.	£ s. d.	s. d.
Ploughing . .	21¾	1½	0 13 3	8 6	1 0 2	13 2
Cultivating . .	90	8	0 19 8	2 5	1 7 10	3 5
Disc Harrowing .	74½	8¼	0 17 11	2 2	1 6 1	3 2
Culti-packing . .	71½	14¼	1 1 7	1 6	1 9 4	2 0½
Cutting and Binding	105¾	5	0 15 2	3 0	1 2 3	4 5
Cutting and Blowing Silage . . .	8	1½	0 15 8	9 9	1 1 1	13 4
	Quarters.	Quarters per day.	Cost per day.	Cost per quarter.	Cost per day.	Cost per quarter.
			£ s. d.	s. d.	£ s. d.	s. d.
Threshing . .	684	22	0 18 9	0 10	1 4 11	1 1

Full details will be found in the appended Tables with regard to the cost of running of the tractor, driver's wages, fuel consumption and overhead charges. It should be noted that the overhead charges are based on the consumption of paraffin.

TABLE II.

Ploughing.

Acres	21¾			
Days	14			
Acres per Day	1½			
Paraffin consumed	94 gals. = 4·3 gals. per acre.			
Petrol consumed	22 pints = 1 pint per acre.			
Lubricating Oil consumed ...	4 gals. = 1·5 pints per acre.			
Cost per annum (exclusive of driver's wages)—				
Paraffin	94 gals.	£4 6 4		
Petrol	22 pints	0 4 2		
Lubricating Oil	4 gals.	0 16 0		
			£5 6 6	
Overhead charges—Repairs		£1 6 3		
Depreciation ...		2 12 10		
			3 19 1	
			£9 5 7	

Tractor—
- Cost per day ... ... 13s. 3d.
- „ acre ... ... 8s. 6d.

Driver's wages (including bonus)—
- Per day ... ... 6s. 11d.
- „ acre ... ... 4s. 8d.

Summary—			
Total cost per day—Tractor	£0 13 3		
Driver	0 6 11		
		£1 0 2	
Total cost per acre—Tractor	£0 8 6		
Driver	0 4 8		
		£0 13 2	

TABLE III.

Cultivating.

Acres	90		
Days	11		
Acres per day	8¼		
Paraffin consumed	103 gals. = 1·1 gals. per acre.		
Petrol consumed	37 pints = 0·4 pints per acre.		
Lubricating Oil consumed ...	7 gals. = 0·6 pints per acre.		
Cost per annum (exclusive of driver's wages)—			
Paraffin	103 gals.	£4 14 7	
Petrol	37 pints	0 7 0	
Lubricating Oil	7 gals.	1 8 1	
			£6 9 8
Overhead charges—Repairs		£1 8 9	
Depreciation ...		2 17 11	
			4 6 8
			£10 16 4

Tractor—			
Cost per day	19s. 8d.		
„ acre	2s. 5d.		
Driver's wages (including bonus)—			
Per day	8s. 2d.		
„ acre	1s. 0d.		
Summary—			
Total cost per day—Tractor		£0 19 8	
Driver		0 8 2	
			£1 7 10
Total cost per acre—Tractor		£0 2 5	
Driver		0 1 0	
			£0 3 5

TABLE IV.

Disc Harrowing.

Acres	74½
Days	9
Acres per day...	8¼
Paraffin consumed	81 gals. = 1·1 gals. per acre.
Petrol consumed	15 pints = 0·2 pints per acre.
Lubricating Oil consumed ...	4 gals. = 0·4 pints per acre.

Cost per annum (exclusive of driver's wages)—			
Paraffin	81 gals.	£3 14 3	
Petrol	15 pints	0 2 10	
Lubricating Oil	4 gals.	0 16 0	
			£4 13 1
Overhead charges—Repairs		£1 2 8	
Depreciation ...		2 5 6	
			3 8 2
			£8 1 3

Tractor—	
Cost per day	17s. 11d.
„ acre	2s. 2d.
Driver's wages (including bonus)—	
Per day	8s. 2d.
„ acre	1s. 0d.

Summary—		
Total cost per day—Tractor	£0 17 11	
Driver	0 8 2	
		£1 6 1
Total cost per acre—Tractor	£0 2 2	
Driver	0 1 0	
		£0 3 2

TABLE V.

Culti-packing.

Acres	71½	
Days	5	
Acres per day...	14¼	
Paraffin consumed	53	gals. = 6 pints per acre.
Petrol consumed	15	pints = 0·2 pints per acre.
Lubricating Oil consumed ...	3	gals. = 0·3 pints per acre.

Cost per annum (exclusive of driver's wages)—			
Paraffin	53 gals.	£2 8 7	
Petrol	15 pints	0 2 9	
Lubricating Oil	3 gals.	0 12 0	
			£3 3 4
Overhead charges—Repairs		£0 14 10	
Depreciation ...		1 9 10	
			2 4 8
			£5 8 0

Tractor—	
Cost per day	£1 1 7
„ acre	0 1 6
Driver's wages (including bonus)—	
Per day	7s. 9d.
„ acre	0s. 6½d.

Summary—		
Total cost per day—Tractor	£1 1 7	
Driver	0 7 9	
		£1 9 4
Total cost per acre—Tractor	£0 1 6	
Driver	0 0 6½	
		£0 2 0½

TABLE VI.

Cutting and Binding.

Acres	$105\frac{3}{4}$				
Days	21				
Acres per day	5				
Paraffin consumed	156 gals. = 1·5 gals. per acre.				
Petrol consumed	44 pints = 0·4 pints per acre.				
Lubricating Oil consumed ...	9 gals. = 0·7 pints per acre.				
Cost per annum (exclusive of driver's wages)—					
Paraffin	156 gals.	£7	3	3	
Petrol	44 pints	0	8	4	
Lubricating Oil	9 gals.	1	16	1	
					£9 7 8
Overhead charges—Repairs		£2	3	8	
Depreciation ...		4	7	9	
					6 11 5
					£15 19 1

Tractor—					
Cost per day	15s. 2d.				
" acre	3s. 0d.				
Driver's wages (including bonus)—					
Per day	7s. 1d.				
" acre	1s. 5d.				
Summary—					
Total cost per day—Tractor		£0	15	2	
Driver		0	7	1	
					£1 2 3
Total cost per acre—Tractor		£0	3	0	
Driver		0	1	5	
					£0 4 5

TABLE VII.

Cutting and Blowing Silage.

Acres	8				
Days	5				
Acres per day	$1\frac{1}{2}$				
Paraffin consumed	38 gals. = 4·8 gals. per acre.				
Petrol consumed	8 pints = 1 pint per acre.				
Lubricating Oil consumed ...	$2\frac{1}{2}$ gals. = 2·5 pints per acre.				
Cost per annum (exclusive of driver's wages)—					
Paraffin	38 gals.	£1	14	10	
Petrol	8 pints	0	1	5	
Lubricating Oil	$2\frac{1}{2}$ gals.	0	10	0	
					£2 6 3
Overhead charges—Repairs		£0	10	8	
Depreciation ...		1	1	4	
					1 12 0
					£3 18 3

Tractor—			
Cost per day	15s. 8d.		
„ acre	9s. 9d.		
Driver's wages—			
Per day	5s. 5d.		
„ acre	3s. 7d.		
Summary—			
Total cost per day—Tractor		£0 15 8	
Driver		0 5 5	
			£1 1 1
Total cost per acre—Tractor		£0 9 9	
Driver		0 3 7	
			£0 13 4

TABLE VIII.

Threshing.

Quarters	684		
Days	31		
Quarters per day	22		
Paraffin consumed	276 gals. = 1 gal. per hour.		
Petrol consumed	97 pints = 0·3 pints per hour.		
Lubricating Oil consumed . .	20 gals. = 0·6 pints per hour.		
Cost per annum (exclusive of driver's wages)—			
Paraffin	276 gals.	£12 13 3	
Petrol	97 pints	0 18 2	
Lubricating Oil	20 gals.	4 0 3	
			£17 11 8
Overhead charges—Repairs		£3 17 3	
Depreciation ...		7 12 7	
			11 9 10
			£29 1 6

Tractor—			
Cost per day	18s. 9d.		
„ quarter ...	0s. 10d.		
Driver's wages—			
Per day	6s. 2d.		
„ quarter	0s. 3d.		
Summary—			
Total cost per day—Tractor		£0 18 9	
Driver		0 6 2	
			£1 4 11
Total cost per quarter—Tractor ...		£0 0 10	
Driver ...		0 0 3	
			£0 1 1

The above figures speak for themselves, and call for few remarks. It may be stated, however, that the tractor was only working 96 days, which makes the charge for depreciation very high, nearly 30 per cent. of the total cost. If it had been in constant employment the depreciation would have been spread

over a greater number of operations and the cost per acre considerably reduced.

Table II. *Ploughing.*—A two-furrow plough was used and the soil varied from a calcareous loam to a stiffish clay. The cost of horse ploughing during the same period was £1, 0s. 3d. per acre.

Table III. *Cultivating.*—In several cases harrows were attached behind the cultivator.

Table IV. *Disc Harrowing.*—Harrows were attached in most cases.

Table V. *Culti-packing.*—The culti-pack is an American implement and so far has been little used in this country. It has a consolidating and at the same time a mulching effect on the soil, thereby bringing it into a condition which is so important for the satisfactory germination and healthy growth of the plant, and which is particularly necessary in sowing down land to grass. It combines the work of a harrow and roll, with this advantage, that while it packs the soil below the surface, making a firm seed-bed, it leaves a mulch on the top, which prevents loss of moisture.

The operation is an inexpensive one, the acreage covered per day being 14¼ acres at a cost of 2s. 1½d. per acre.

Table VI. *Cutting and Binding.*—The tractor was used for several acres of Demonstration Plots, where the work was necessarily slow. It should also be noted that the corn was badly laid, and in most cases cutting in one direction only was possible. These two factors largely account for the small acreage cut per day.

Table VII. *Cutting and Blowing Silage.*—The estimated yield of green material carted *into* the silo was 9 tons per acre. This makes the cost per ton 1s. 6d.

Table VIII. *Threshing.*—The threshing machine is a small one and the output (22 quarters per day) is very low. Even so, the cost is less than that of hired tackle, and if a full-size machine were used the cost per quarter would be considerably reduced, there being very little saving of labour with the smaller machine.

FARM PESTS—BIRDS.[1]

JAMES RITCHIE, M.A., D.Sc., F.R.S.E.,
Natural History Department, Royal Scottish Museum.

BIRDS AND GRAIN CROPS (*continued*).

The Finches.—Of the smaller British birds the finches (Family *Fringillidæ*) are probably the most familiar, partly because they comprise a wide range of species, partly because their appearance

[1] Articles in this series, dealing with Mammal Pests, commenced in the JOURNAL in July 1922. The first article on Bird Pests appeared in January 1924.

is distinctive, and mainly because some of them are amongst the most numerous of British birds. In an area of West Lothian covering 10,000 acres, and including arable land, woodland and hill pastures, the late Capt. S. E. Brock found in 1913 that the house-sparrow was the commonest of the nesting birds, with a total of 2600 pairs, then came the rook with 2330 pairs, and closely after the song-thrush and the blackbird, followed the chaffinch with 1800 pairs—two finches included among the five commonest birds.

Apart from the house-sparrow and the chaffinch, the finches which must be considered in relation to the grain crop include the greenfinch, the tree-sparrow, the linnet and two buntings—the yellow-bunting or yellow-hammer and the corn-bunting.

These are all small birds, characterised by the possession of a short, thick and sturdy beak, the upper and lower portions of which are almost equal in size, and meet to form a stout cone—a typical seed-eating beak. The buntings, however, are to be distinguished from the true finches by the smaller size of the upper half of the beak in relation to the lower, and by the incurved edges of both halves. A characteristic habit of the finches is that they flock together in winter, feeding in companies which pay frequent visits to the stack-yard.

Migratory movements affect the seasonal numbers and economic activities of certain members of the group, but they must be considered in relation to each species since they are peculiar to each.

The House Sparrow.—Although it is the commonest of British birds, it may be doubted if the harmonious tints of the plumage of the house-sparrow (*Passer domesticus*) have received the appreciation they deserve, for where it is most abundant it makes its worst appearance, covered with the grime of cities. The plumage varies with sex and age, but in general the upper surface is of a chestnut brown with black longitudinal streaks, the head, nape and rump ashy grey and the under parts greyish white. Distinctive marks are the bright grey of the ear region, the chestnut stripe over the eye and the single dusky white bar on the wing. The male is adorned with a black stomacher extending from chin to breast. In winter the bill is brown, in summer black. The female sparrow is more uniformly brown, darker on the back, but the black streaks are less pronounced and the black "apron" is absent. The short stubby build of body is characteristic, especially of adult birds.

Sparrows nest in the most varied places, and the character of the nest may alter with its site. Thus under eaves, in holes in walls, in ivy or other creepers, an untidy mass of dead grass and straw appears to be rammed together, though the interior is cosily lined with feathers; but in hedges or in trees a shapely domed nest is frequently constructed. Nest-building is carried on through a great part of the year, open winters, such as those of 1922-23 and 1924-25, leading to domestic activity even before the new year has set in. It is noticeable that nesting begins earlier in large towns than in the country, perhaps because the radiated warmth of the city throws off more rapidly the shackles of winter.

The early nesting and the fecundity of sparrows has much to do with their menace to agriculture. Three and often more broods are reared in a season, and a clutch of five or six eggs is

the rule. The eggs are said to be brooded by the hen only, and so the death of a hen sparrow is of more consequence than the death of a cock.

The Food of the Sparrow.—Its beak proclaims the house-sparrow as a typical seed-eater. Its food consists of seeds of all kinds, weed-seeds throughout the greater part of the year, grain when it is available. But this does not mean that the sparrow confines itself to a seed or even a vegetarian diet. It devours green food, being particularly fond of the fresh shoots of peas, tearing to pieces the flowers of crocuses and primroses, the buds and blossoms of apple trees and berry bushes. And all the time, whenever opportunity offers, it seizes the insect, grub or adult, which crosses its path.

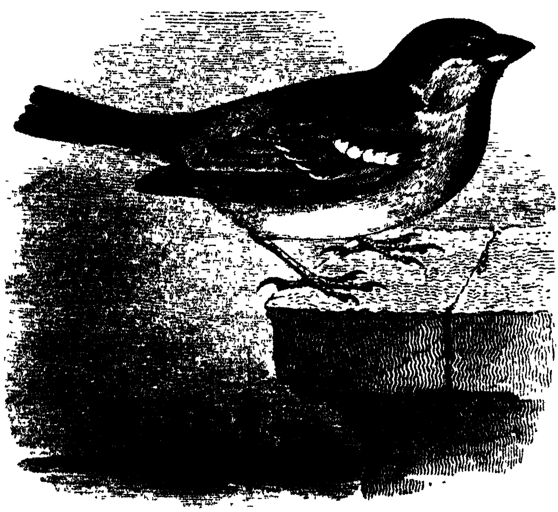
The nature of the food has a seasonal routine: in autumn and winter seeds, including grain, predominate, in early spring and throughout the summer, insects make up a large proportion of the diet, and in early summer young green shoots and blossoms pay toll. This seasonal routine is intimately connected with the domestic affairs of the sparrow's year. The taking of insects on a large scale in spring and summer is due to the demands of the young broods, which, like young grouse, require such food. The greatest destruction of green shoots and of garden flowers follows upon the fledging of the spring broods, for my experience is that the old birds still prefer grass- and weed-seeds, except when drought drives them to more succulent food.

Sparrows fall foul of the grain crop at various stages, but their habits and seasonal movements cause the intensity of the damage to vary at each stage. Throughout most of the year they frequent the haunts of men and are rare in open country districts, away from the vicinity of the homestead. Thus the sowing, whether it be spring or autumn, escapes lightly except in the immediate neighbourhood of the farm buildings. It has been said that the milky ears are taken to feed the young; but, in Scotland at any rate, little of the crop has reached that stage ere the majority of the season's broods have hatched and flown. During the weeks before harvest, however, and after the crop has been cut and stooked, the damage is very serious. Even then it is strictly limited in area; for, while the open country escapes, the fields near the farm and the fields near village, town or city are swooped upon by hordes of birds. A sort of local migration has become the habit at this season, city gardens are deserted, and swarms of town sparrows, largely composed of the young of the year, make their way to the outskirts, where they remain until the fields are clear of crop. Some doubtless linger on about the stackyard, augmenting the numbers of the native sparrows, and contributing with them to damage ricks and thatch in their further search for grain.

It ought not to be forgotten, also, that in addition to their direct attack upon the field crops, farm sparrows steal by no means a negligible proportion of the food set out for their betters in the poultry yard.

Economic Significance.—Many attempts have been made to estimate the economic value of the house-sparrow, and with practical unanimity the statisticians have condemned it, on account

of the large proportion of grain in its food. Do the statistics which have been collected give a fair interpretation of the truth? They seem to me to be biassed against the sparrow, for no attempt has been made to eliminate from the total of grain debited against it that which could be of no agricultural value. When Mr. J. H. Gurney tabulates, month by month, the food of the sparrow [1] and states that corn is its principal customary food in every month of the year, one is compelled to ask, "Where did the sparrow get its corn in every month from October to June?" Surely much of it must have been waste corn, from the stubble, from the spillings of sacks in transit and horses' nose-bags, from the shakings in the stackyard, even from the droppings on the roads and streets. Such waste corn ought to be eliminated from the debit sheet.



HOUSE-SPARROW.*

The more recent researches of Dr. Walter Collinge [2] bring out the proportion of grain in agricultural districts as 75 per cent. of the total volume of food devoured, but here also no allowance is made for waste corn. Now, it is known that the sparrow may pick up quite a good living in a very casual way. How else could it be that the extension of railroads has been sufficient to account for its spread? Sparrows reached Corrour in Inverness-shire along the railway, picking up stray food dropped from passing waggons, and in this outlying spot they make a comfortable living, but they have not yet invaded the old established farm at the head of Loch Treig, in the near neighbourhood. The picking up of waste food is habitual and must be allowed for.

When allowance is made for waste grain, we are still faced by

[1] "Ornithology in Relation to Agriculture and Horticulture." Edited by John Watson, 1893, p. 80.

[2] *Journal of the Board of Agriculture*, September 1918.

* From Saunders' *Manual of British Birds*, by courtesy of the Publishers, Messrs Gurney & Jackson.

the problem of balancing good grain against injurious insects and weed-seeds, destroyed to the benefit of the farmer. In both cases the benefits are substantial. Seeds of knot and other grasses, violets, chickweed, spurrey and goosefoot, yarrow, dock, groundsel, sorrel and buttercup, are eaten in considerable quantities. In one of the Farmers' Bulletins (No. 54, 1904) of the United States Department of Agriculture, Beal estimates the amount of weed-seeds eaten by various sparrows during their winter sojourn in the State of Iowa at about 875 tons. But against this has to be reckoned the fact that, as an interesting experiment of Dr. Collinge showed,[3] some of the seeds are not destroyed, but may subsequently germinate, so that the sparrow becomes to this extent a weed-distributor.

The benefits due to insect destruction are also noteworthy. Indeed in fruit growing districts they definitely turn the scale in favour of the sparrow; for Dr. Collinge, in the paper cited above (Footnote 2), finds that 35 per cent. by volume of the food consists of injurious insects in addition to 20 per cent. of weed-seeds, to say nothing of the 88 per cent. of injurious insects consumed by the nestlings. Many individual observations and estimates to the same effect have been made, which it would be unprofitable to quote in detail; but one typical example may be given. On a terrace in a busy street in Paris, M. de la Sicotière counted 1400 wing cases of cockchafers, dropped beneath a single sparrow's nest during the fortnight when the nestlings were being fed.

The insects which suffer most severely in Britain are beetles and two-winged flies (*Diptera*) and their grubs, the caterpillars of moths and butterflies, and greenflies.

It comes to this, that in the open country, where it is not superabundant, the sparrow probably does much more good than harm, and that it is only in the immediate vicinity of farmsteads and in the surroundings of centres of human population, villages, towns or cities, that the damage it does seriously exceeds its good deeds. Man and not nature has made it a thief and robber.

The Destruction of Sparrows.—This conclusion suggests that the remedy for sparrow devastation should not be far to seek. The consistent reduction in numbers of town and village sparrows and of those about farm buildings, especially the removal of the many opportunities afforded them for unchecked multiplication there, in house rhones, in old ivy and like places, should reduce those summer migrations to the corn fields which account for the most serious damage. Active measures should be taken during the prolonged breeding season, from early spring to summer, for the destruction of nests and eggs. In certain districts in France excellent results have been obtained through dislodging nests by means of a long pole with a hook attached to the end. A cord may be fastened to the neck of the hook so that an oblique pull may more effectively dislodge the nest or eggs.

During hard weather large cage traps with grain as a bait have been successfully employed. In Britain the formation of sparrow clubs has made some progress, the great advantage being that these organise the attack through a whole district; for where

[3] "The Food of some British Wild Birds," 1913, p. 73.

sparrows form a general pest on account of excessive numbers, isolated action is of little avail.

The methods which have been adopted for scaring sparrows from threatened crops—the erection of "scare-crows," the suspension of fragments of mirror or glass on a cord so that their flashes may disturb the feeding birds, the hanging of pieces of paper or cloth the movement of which agitates the birds, the stretching of threads across a seed-bed—while they may be of more or less value, each in its own degree, over small areas, are of no account in the larger operations of the farm.

The Tree-Sparrow.—In several respects the habits of the tree-sparrow (*Passer montanus*) differ from those of its more abundant relative, yet there is a community of feeding during the winter months which makes it desirable that the two species should be distinguished. The tree-sparrow bears a superficial resemblance to the house-sparrow, but its build is less stubby and more slender, its movements more graceful and active. Its distinctive colour markings are a bright chestnut crown, nape and hind neck, a black patch on white cheeks, a less extensive black apron which scarcely extends to the breast, and two narrow though distinct white bars on each wing. Furthermore in the tree-sparrow the plumage of both sexes is similar.

In Britain the tree-sparrow is widely distributed, though it cannot be said to be a common bird; indeed in the western parts of Scotland it is very rare, and even in the eastern districts, where it is spreading, it is more sparsely distributed than in England. In contrast to the house-sparrow, it prefers the open country and seldom frequents the haunts of man. In small colonies it nests in trees or in holes, building a rude nest of grass, hay, wool and miscellaneous material, lined with feathers, like that of the house-sparrow.

Like the latter it feeds upon weed-seeds, fruits and insects, but the paucity of numbers of the resident birds relieves it of the imputation of doing serious damage to growing crops. In the area of Linlithgowshire, where, in 1913, the late Capt. Brock found 2600 pairs of breeding house-sparrows, there were only 22 pairs of tree-sparrows.

In addition to the resident birds, migrant flocks must be reckoned with, for while the foreign wanderings of the house-sparrow consist only of a very limited and occasional influx to the south-east coast of England and perhaps a slight cross-channel departure in autumn, the tree-sparrow performs regular autumn and spring migrations to and from Britain. From the beginning of October to early in November large flocks arrive on the east coast from the Continent, to which they return from mid-March to mid-April. The visit of the immigrants covers a period when they can do little harm to agriculture, and when they do some good by devouring weed-seeds and the hibernating grubs of insects, but during this period they frequent stack-yards, along with house-sparrows and other finches, and run the danger which threatens all who keep bad company.

Both the resident and immigrant tree-sparrows, however, may be regarded as agricultural benefactors rather than pests.

The Chaffinch.—Whatever may be the final decision, the same verdict cannot so lightly be passed upon the chaffinch (*Fringilla cœlebs*), which has its detractors and its advocates. It is abundant throughout the British Isles, ranking fifth on the list of commonest birds in the Linlithgowshire census to which I have already referred. The bright variegated plumage of the male makes it conspicuous at all times of the year, the ruddy or pinkish cheeks, breasts and underparts, the slate-blue head, chestnut brown back shading into a yellowish-green rump, the wings barred with yellowish white and the striking white patch on the shoulder. The female is much less conspicuously marked, of an olive brown colour, without the ruddy hues which add so greatly to the beauty of her partner.

The nest, securely lodged in the fork of a tree or in a hedge, is a dainty structure of moss, lichens and wool, lined with hair or feathers, and the reddish brown, streaked eggs, four to six in number, are laid in April or May. Two broods may be reared in a season.

Food and Economic Significance.—Like all the finches, the chaffinch is a seed-eater, devouring vast quantities of weed seeds, chief amongst which are charlock, knotgrass, chickweed, groundsel and goosefoot, all items to be counted to its credit. Its fondness for the oily seeds of the mustard group (cruciferous) leads it sometimes to attack newly sown or sprouting turnip seed in the fields, and in gardens turnip and radish beds may suffer, but the agricultural damage is insignificant, since, in any case, turnips have to be thinned long after the chaffinch attack is over. It is a common sight to see numbers of chaffinches picking up seeds, and probably insects as well, along the tide-line on the shores of the Firth of Forth.

They have been said to do a considerable amount of damage to the grain crop, and a superficial examination of the results of crop content analysis would appear to support this view. The very careful study of 527 individuals collected at all seasons of the year, made by Messrs. F. V. Theobald and W. M'Gowan,[4] showed that "corn seems to be taken all the year round, but less from May to September," but the authors conclude that "it is probably largely from poultry food in farmyards, as well as from the stubble, from the stackyard and from standing corn." Other observers, on the other hand, such as Ritsema Bos, definitely state that the chaffinch does not take grain from the ear. The worst that can be said of the chaffinch, as regards the corn crop, is that at the spring and autumn sowings it picks up exposed or sprouting grains.

In the garden, apart from its destructiveness to cruciferous seed-beds, it has been stated that it does much damage to fruit blossoms; and to this aspect of its activities I shall return in discussing birds and the fruit garden.

While seeds form its staple food, the chaffinch, of all the finches, is that which most consistently mixes its vegetarian with an animal diet. It is constantly to be seen sallying from a perch in pursuit

[4] "The Food of the Rook, Starling and Chaffinch, Supplement 15, *Journ. Board of Agriculture*, May 1916, p. 38.

of insects in the air or searching foliage and plant shoots for caterpillars or greenflies. Occasionally it eats wireworms, click-beetles, flea-beetles, blossom weevils, earwigs and such like.

As to the relative proportions of these different types of food, it has been noted that the stomach contents of chaffinches reveal an amount of insect food very much less than the insect-catching activities of the bird would lead one to expect. A very interesting case is described by Messrs. Theobald and M'Gowan in the paper cited (footnote 4), and because of its importance, not only in its bearing upon the chaffinch, but in its revelation of the dangers which confront a too literal reading of crop-content statistics, it deserves quotation: "It is difficult to say why so little food is found in the chaffinch, unless it is that the greater part of the insect diet of this bird is of such a frail nature that it is soon destroyed. That this is the case is borne out by the following experience:—In July, 1910, some chaffinches were observed in the garden of one of the writers stripping the Black Fly (*Aphis rumicis*) off broad beans and also eating Rose aphides. It was easily seen where they had worked and cleared off the Aphis. The birds were shot and examined carefully next day; 2 whole aphides were found in one, 3 in another, and 6 wings only; the majority must thus have been so broken up as to be unidentifiable" (p. 38).

Keeping in mind this disappearance of insect food, we may look at the results of two recent enquiries which have attempted to give a statistical interpretation of the chaffinch's food. Mr. H. S. Leigh in his report on the food of this species (footnote 4, p. 49) states, from an examination of 357 individuals, that "weed-seeds were in greatest abundance, having been found in 67 per cent. of the crops, and in 86 cases in which they occurred they formed 95 per cent. of the food contents. Injurious insects occurred in 14 per cent. of the crops, the percentage of 'weevils' (*Rhyncophora*) being 9. Many instances in this enquiry show that the chaffinch takes large quantities of some of the most troublesome weed seeds, such as chickweed, dock, hawkweed, knotgrass; chickweed especially being taken in large quantities. Grain was found in 41 per cent. of the birds; but it appeared in most cases to be taken from manure or ricks in farmyards and not from the cultivated land, so that the bird was really doing little or no damage to the farmer. Seeds of value to the farmer other than grain (such as clover, turnip) were found in only 3 per cent. of the birds; this number is surprisingly small in view of the general impression prevailing as to the destructive habits of the chaffinch."

A later investigation by Dr. W. Collinge[5] sets out the food eaten in relative proportions according to its volume. The results are based on an examination of 128 individuals. "Of the total food consumed in the year 25 per cent. is animal food and 75 per cent. vegetable food. Of the former 16·5 per cent. consists of injurious insects, 1·5 per cent. of beneficial insects, 4·5 per cent. of neutral insects, 1·0 per cent. of spiders, and 1·5 per cent. of earthworms. The bulk of the vegetable food, viz. 56 per cent., consists of weed seeds, 4·5 per cent. of blossom buds, 3·5 per cent. of fruit

[5] "Some Further Investigations on the Food of Wild Birds," *Journal of the Board of Agriculture*, March 1919, p. 1450.

pulp, 8·5 per cent. of cereals, and 2·5 per cent. of miscellaneous vegetable matter."

These relative proportions of the food of the adult chaffinch are significant enough of the value of the bird, but the nestlings make even a better showing. "The whole of the food of the 32 nestlings was of an animal nature, 98 per cent. consisting of injurious insects (aphids, larvæ of the Winter Moth (*Cheimatobia brumata*, Linn.), small Geometrid larvæ, the Apple Blossom Weevil (*Anthonomus pomorum*, Linn.), and other coleoptereous larvæ), 1·0 per cent. of beneficial insects, and 1·0 per cent. of neutral insects."

Dr. Collinge comes to the conclusion "that both the farmer and the fruit-grower would be the sufferers if it were destroyed in any great numbers, for its activities as a destroyer of injurious insects must be of great value and fully compensate for the injuries it inflicts."

The migrations of the chaffinch have some bearing upon its agricultural value. While the native British birds congregate in winter and move in flocks about the country side and the stock-yards, there is no evidence that they leave the country for warmer climes. On the other hand the native population is greatly augmented in autumn and winter by the immigration of large flocks from north-western and central Europe. These arrive on the east coast, but ultimately become dispersed over a great part of the country. They reach Britain from mid-September to mid-October and depart in March and April. For a short period of their sojourn, and in the area where it is grown, freshly sown autumn wheat is available for the immigrants; but during by far the greater part of their stay their diet must consist of weed-seeds and hibernating insects, for many leave the country before the oat crop is sown in spring. The food of the immigrant birds adds to the value of the chaffinch's presence.

In view of the results of prolonged and detailed enquiries, the old notion that the destructiveness of the chaffinch exceeds its usefulness must be abandoned. If, as has been shown, one investigator pronounces in favour of it on account of its destruction of weed-seeds, and another on account of its destruction of insects, surely these two credits taken together are sufficient to tilt the scale definitely in favour of the chaffinch, and to decide that, over all, it ought to be regarded as a farmer's friend, even if not a particularly whole-hearted one.

The Greenfinch or Green Linnet.—Much less abundant than either the chaffinch or the yellow-hammer, the greenfinch (*Chloris chloris*) must nevertheless be regarded as one of the ordinary birds of the country-side. It is common as a resident in most parts of the mainland, living in small colonies in thick shrubbery, hedges or plantations. As its name suggests its predominant colour is green, olive green on the upper parts and greenish yellow on the forehead, face and under parts. The wings are slate grey with bright yellow margins, which, with the yellow base of the tail, give a conspicuous touch of colour to the bird in flight. The females are somewhat duller in colour than the males. The eggs, speckled brown on a creamy white ground, vary from four to six in number,

and the first clutch is laid in April or May. Second and sometimes third broods are reared in a season.

Economic significance.—The greenfinch is all but an out-and-out seed-eater, destroying fewer insects than any of the other common finches, and feeding even its nestlings to a considerable extent upon seeds pulped to a starchy consistency. It is not surprising, therefore, that a large proportion of the birds examined have contained grain, gathered sometimes from the newly sown fields, but more often from the stubble and the stackyard, where flocks of greenfinches may be seen in the company of chaffinches and buntings during the autumn and winter.

Grain by no means forms their chief sustenance, however, for they seem to prefer lesser seeds, whether of cultivated or uncultivated plants. Amongst the former they sometimes do a considerable amount of damage, greedily devouring turnip and sainfoin seed, either newly sown or ripening. It has been recorded that in Kent a field of milled sainfoin has had to be ploughed up owing to flocks of greenfinches taking all the seeds. In country gardens they do not confine their attention to seeds, but destroy flower blossoms and fruit buds, though they do no damage to fruit itself. Of weed seeds they eat a vast quantity, chiefly of chickweed, common sorrel and charlock, dandelion, dock, plantain and goosegrass, and this is the one solid benefit which stands against their misdeeds, a benefit modified to some extent by the knowledge that some of the seeds pass unharmed through the food-canal and may be scattered, to germinate in other places.

The majority of the greenfinches nesting in Britain migrate overseas in September and return to this country in March, but their absence is more than compensated for by the immigration of large numbers from north-western and central Europe, which reach our shores in October and depart again in early spring. The possibility of damage by the immigrants is limited by the season, so that their destruction of weed seeds may well outweigh the harm occasionally done by the residents.

The Linnet.—The linnet (*Acanthis cannabina*), variously known as the grey, brown or red linnet to distinguish it from the green linnet, is less common than the finches just described, and its agricultural importance is lessened also by its habit of preferring open wastes and uncultivated rather than cultivated land. The male bird is easily picked out by its general warm brown colour, enlivened by a crimson forehead, crown and breast, and under parts shading from fawn almost to white on the belly. The female is darker and browner than the male and lacks the distinctive crimson. The linnet generally nests in whin bushes, four to six eggs being laid in April.

It does an insignificant amount of damage to grain, but on the east coast of England the large flocks which sometimes occur there have proved very destructive to seed of turnips, rape, cabbage and similar cruciferous crops, either in the seed bed or when grown for seed. The staple food, however, throughout the country is weed seeds, charlock, groundsel, chickweed, dock, knotgrass being taken in great quantities. The activities of the native birds in this respect are ably supplemented by the large flocks which visit this

country from the Continent during the winter, at which period of the year the individuals which have bred in Britain move southwards, some across the channel. To its record as a weed-destroyer must be added a certain amount of insect-destruction, for not only does the adult bird feed upon moths and caterpillars, but the nestlings are supplied with grubs of flies, caterpillars of moths, greenflies, beetles and miscellaneous insects, as well as with pulped seeds. Except in a limited area in Britain, and on occasions, the linnet must be regarded as a useful bird.

The Buntings.—Of some fifteen species of buntings which have been seen in the British Isles only two concern the farmer, the yellow-hammer or yellow bunting and the corn bunting. Against both the charge has been made that they do damage to grain crops, in the field or in the rick, but it can be only in exceptional cases that the harm is serious enough to discount the good each species undoubtedly does. As a rule adult buntings make more use of insect food than do most of the true finches, from which, as has already been pointed out, they may be distinguished by the incurved edges of the beak and inequality of its upper and lower portions.

The Yellow-Hammer or Yellow Bunting (*Emberiza citrinella*) is one of the familiar birds of the hedgerow, much commoner in Scotland than the greenfinch but less common than the chaffinch. Its bright plumage, lemon yellow on the under parts, orange brown on the upper with streaks of rich brown on back and flanks, and its simple song, which Scottish children interpret as "Deil, deil, deil, tak' ye," readily distinguish it. The mossy hair-lined nest, placed low in a whin-bush or on the ground, is built in April, and by the end of that month, or early in May the first clutch of eggs, three to five in number, is laid. Two or more broods are reared in a year.

Economic significance.—As in the case of the chaffinch, a superficial examination of the results of food analysis would suggest that there was good ground for the charges of corn destruction which have been brought against the yellow-hammer, for undoubtedly a considerable quantity of grain is devoured. Thus in her examination of twenty-one Scottish individuals, Miss Florence[6] found that twenty contained corn. But of the twenty-one specimens, nineteen were killed in January, one in March and one in July, so that the corn could have no agricultural value and must be reckoned out of count. Dr. W. Collinge, in a paper already referred to (Footnote, p. 1452), paid particular attention to the seasonal incidence of grain in the food of this species, and in an examination of fifty-eight adults showed that, while in nine months of the year the volume of grain ranges from about one-twentieth to one-hundredth of the total volume of food, in only three months was the quantity remarkable, when, in August, September and October, it varied from 22 to 36 per cent. of the total food. Even then the corn was probably valueless from an agricultural point of view, as is certainly suggested by the yellow-hammer's well-known habit of gathering in flocks in autumn on the stubble or in hard weather in the stackyard.

[6] "The Food of Birds." *Trans. High. and Agr. Soc. Scotland*, 1912, p. 180.

Against this negligible damage, which can only become of moment where the yellow-hammer occurs far in excess of its usual numbers, must be placed the considerable amount of good done by the species. In summer the adult birds eat many injurious insects, beetles, moths, caterpillars and the like, as well as slugs, millipedes and earthworms, and they feed their young wholly on insect food, 99 per cent. being insects injurious to cultivated crops, according to Dr. Collinge's computation. In spite of this, weed-seeds form their chief fare, and their destruction of the seeds of plantain, chickweed, knotgrass, dock and the like is prodigious, since, again according to Collinge, these aggregate 57·5 of the total volume of food.

So far as is known native yellow-hammers do not leave this country in winter, but from October and November to spring their numbers are added to by the immigration of continental birds, which, limited almost entirely to weed-seeds for food, add to the benefits conferred by this generally useful bird.

The Corn Bunting (*Emberiza calandra*) is rather larger in size, but more sombre in colour than its relative, greyish brown above and creamy white below, streaked on back, throat, breast and flanks with dark brown. The brown of the face is broken by a pale eye-brow stripe. It is not generally distributed throughout the country, occurring sporadically in limited spots, although in some places, usually in the neighbourhood of the coast, it is common. Here it frequents open and generally cultivated land, building its hair-lined nest in May in some well-hidden place on the ground. Four to six eggs are laid in late May or early June.

Economic significance.—Two charges have been brought against the corn bunting, first that it takes grain from the field, and secondly that it damages ricks by pulling out straws for the sake of the ear. On neither count is the charge a serious one; it may take some grain, but the major quantity is waste grain from the stubbles or stackyard, where flocks may be seen traversing the ground during the autumn and winter months. Nor can the damage to ricks be serious, for, as has been pointed out, it can be no easy task for so small a bird to pull out of a well-built rick a straw with the ear attached.

Indeed the main food of the corn bunting is insects and weed-seeds in summer, and in winter weed-seeds and the waste of the harvest fields. Like the yellow-hammer it feeds its young almost wholly on insects, the majority of them harmful to crops. Many of our native birds leave Britain in winter, but their place is then taken by flocks from over-seas, which carry on the good work of weed-seed destruction.

SUGAR BEET GROWING IN SCOTLAND.

I.—REPORT OF THE COMMITTEE APPOINTED BY THE SCOTTISH COUNCIL OF AGRICULTURE.

IN March 1924 the Scottish Council of Agriculture appointed a small Committee to investigate the prospects of sugar beet growing in Scotland. The report of the Committee, dated 16th March 1925, has recently been published in convenient form and copies may be obtained from the Board of Agriculture for Scotland.

The report is divided into six sections. The first concerns the position of the industry in England, where, at the time of the Committee's investigations, three Companies were actively engaged in promoting the cultivation of sugar beet for manufacture at their respective factories. A short description is given of the terms of the contracts entered into with English growers in 1924 and of the methods employed to determine the value of each grower's crop as it arrives at the factory.

It is anticipated that the number of factories available for dealing with the English crop of 1925 will be more than doubled. This notable development is due, as foreshadowed in the second section of the report, to the proposals of the Government to standardise for a period of ten years on a gradually diminishing scale the subsidy on the manufacture in this country of sugar from home grown beet. The British Sugar (Subsidy) Act, 1925, which achieved this purpose received the Royal Assent on 27th March. The first effect of the Act will be, it is hoped, to attract to the enterprise the large amount of capital which is required at the beginning for the provision of factories, machinery and plant, and which, but for the Act, would not be forthcoming for a new industry of this kind. Each new factory costs at least £200,000, of which £150,000 represents the value of machinery and other equipment. In other countries where the industry has been established, and notably in Holland, State assistance has been necessary in the initial years, and the subsequent withdrawal of this assistance has not affected the stability of the industry or impeded its further development. It is anticipated that with the help extended by the Act the home industry will establish itself so firmly that within the ten years period it will be ready without protection to compete on level terms with foreign producers.

Section III. of the Report deals with the cultivation, harvesting and costs of the crop with special reference to Scottish conditions. With regard to cultivation general rules are given for the guidance of farmers, but, as in the case of other crops, the individual grower would require to adapt this advice to suit the condition of his farm or to comply with conclusions formed from his own experience. It is noteworthy that while sugar beet, like potatoes, is a most efficient cleaning crop it does not, with the prescribed manuring, exhaust the soil. The sugar content of the root is derived from sunlight, air and water; and it follows therefore that if the usual practices be adhered to of feeding or ploughing in the tops and leaves on the farm and of recovering from the factory the dried beet pulp for use as fodder, the farmer

returns to the soil a large proportion of the plant foods that the crop has taken from it. Again the roots of the beet pierce and so aerate the soil more deeply and widely than those of other staple crops. On the Continent it is estimated that the subsequent wheat yield is increased by 15 per cent.

The prospects of the sugar beet crop in Scotland are discussed in Section IV. of the Report. It has been sufficiently proved in past years on various farms in Scotland that sugar beet can be grown as satisfactorily as on the Continent, with regard to quality and quantity of the crop per acre. The prime question at issue is whether a sufficient area of satisfactory crop can be secured within a radius of from 30 to 40 miles of a central site to induce the establishment of a sugar factory. That question is at present being investigated on practical lines by the Anglo-Scottish Beet Sugar Corporation, whose headquarters are at 47 Summer Street, Bridgeton, Glasgow. The results obtained last year by this Corporation confirm the view that the crop is suitable for Scotland, but, as might be expected, most farmers will require to gain further experience of its management before they will reap results equal to these obtained in other countries where the industry has been long established. Should the project for the establishment of a factory succeed, farmers within economic range of it will find sugar beet a valuable alternative crop to potatoes, swedes and turnips. Maximum results could not reasonably be expected in the first year or two, and most farmers, too, might require to purchase a few special implements. Apart, however, from these two considerations, it would not appear that the crop will be a more speculative one than others. The burden of the risk is rather upon the manufacturers who have invested large sums of money in their factories.

It is noteworthy that the plans of the Orchard Sugar Company, Ltd., are in an advanced stage for the opening of a factory next autumn at Greenock. It is understood that this Company have arranged for a considerable area of crop this season in Ayrshire, Easter Ross, Argyll and elsewhere.

In Section V. of the Report reference is made to the large amount of employment that the industry provides, and in Section VI. the Committee detail reasons, both agricultural and national, why it seems desirable that a sugar beet industry should be developed in Scotland. Where this industry has been established in other civilised countries it has proved an invaluable asset.

II.—Sugar Beet Growing in the North of Scotland.

Geo. G. Esslemont, M.B.E., B.Sc.,

Director of County Work, The North of Scotland College of Agriculture.

The growing of sugar beet in the North of Scotland may be said to have commenced in 1910, when experimental plots of beet were attempted on the farms of East Pittendreich, Allarburn and Kinloss, in the County of Moray, as part of the programme of field experiments carried out by the North of Scotland College of Agriculture during that season. These experiments were repeated

at various centres in Morayshire in 1911 and 1912, but ceased thereafter in the absence, at the time, of encouragement to farmers to grow the crop on a commercial scale.

The prospect of a substantial State subsidy for home-grown sugar led to the resumption of sugar beet experiments by the Agricultural College in 1923. The trials were distributed over the counties of Aberdeen, Kincardine, Moray, Nairn and Ross and Cromarty, and embraced a variety of soils typical of these counties. There was no special preparation of the soil for these trials, and the tillage operations and management generally were simply those accorded to the turnip crop. Nevertheless, encouraging results were obtained from most of the trials, and particularly in regard to the sugar content, which in a few instances was as high as 17·9 per cent. Samples of beet from all the trial centres were sent to the Anglo-Scottish Beet Sugar Corporation, Nottingham, for analyses, and these compared very favourably with the analyses of beet grown elsewhere under contract with the factory.

In addition to the College Experiments in 1924, trials on a larger scale, ranging from ½ an acre to 2 acres in extent, were also carried out by farmers in co-operation with the Anglo-Scottish Beet Sugar Corporation. Altogether about 13 acres of sugar beet were grown in the North of Scotland in 1924, including 7 acres in Moray and Nairn, 5 acres in Aberdeen, and the remainder in smaller plots in the counties of Kincardine and Ross and Cromarty. The County Organisers of the Agricultural College were closely associated with most of the farmers' trials, and thereby acquired much practical experience and secured reliable data in regard to the yield and quality of the crop, which could not be obtained from small experimental plots.

Despite the inexperience of the growers, the lack of specially adapted implements, and the unfavourable season, fairly good results were obtained in 1924 at all centres where the soil conditions were suitable. In the Moray and Nairn district from 8 to 10 tons per acre of unwashed beet, with a variation of 16 to 17·9 per cent. of sugar, were obtained; while the Aberdeenshire trials gave from 3 to 8 tons per acre of unwashed beet, and a variation of 15·9 to 17·4 per cent. of sugar. In the Cromarty district a plot of fully one-third of an acre gave 12½ tons of unwashed beet per acre, with 19·2 per cent. of sugar. The last result is of special interest, as in this case the crop was grown in accordance with the best methods practised in the successful growing of sugar beet. The seed was sown on the flat in 18 inch drills, and care and skill were exercised in inter-tillage and other cultural operations necessary for a successful beet crop. In all the other trials ridge drills were used, from 24 to 26 inches apart, and the cultural treatment was simply that commonly given to the turnip crop.

In view of the fact that the soil and climatic conditions of Morayshire are quite as favourable to beet-growing as those of the Cromarty district, if not more so, there are good grounds for thinking that the deeper loams of that county could produce 12 tons per acre, at least, of sugar beet under similar treatment.

The formation of the Highland Sugar Beet Syndicate, Cromarty, and the readiness of that company to enter into contracts with

farmers to grow beet at 44s. per ton for cleaned roots, with an addition of 3d. for every one-tenth per cent. over the standard of 15·5 per cent. of sugar, delivered at the nearest port, have had the effect of greatly increasing the acreage under sugar beet in the Moray Firth districts this season. The total area contracted for by the Syndicate amounts to 249 acres, being 193 acres for Ross-shire, 51 acres for Moray and Nairn, 4½ acres for Inverness, and ½ an acre for Banff.

The College of Agriculture is lending its assistance to this development by keeping in close touch with growers and advising them in the best methods of growing beet. It is also continuing its investigations in regard to suitable varieties, manuring and other problems connected with the growing of the crop in the north.

Space does not permit of giving detailed directions on the best way to grow sugar beet, and the following observations are mainly in the nature of suggestions on some of the more important operations of beet-growing, based to some extent on the experience gained in connection with the recent trials.

Sugar Beet.—A knowledge of the habit of growth, and the requirements of the sugar beet plant, is the key to its successful cultivation. A well grown sugar beet is a long, tapering taproot, similar in shape to a parsnip, and weighs from 1 to 2 lbs. It grows almost wholly underground, and develops an extensive system of rootlets and root hairs, which permeate the soil in all directions. Skill in growing beet is largely a matter of developing its extensive system of rootlets, and in giving the plant a downward growth.

The Soil.—The sugar beet requires a deep soil and an open well-drained subsoil. Even the poorer soils of this description will give good results with suitable manuring. Soils with a pan, badly drained and sour soils, and stiff soils with close, cold subsoils are unsuitable and should be avoided. The light, alluvial loams in the river valleys of the north, the deep soils of Morayshire, and the free loams of the Black Isle and Easter Ross fulfil the conditions required for beet-growing. Much has been done by different methods of soil improvement to extend the area of beet-growing land in England and elsewhere, and there is scope for experiments of this nature in the north of Scotland.

Tillage and Farm Manure.—Deep autumn ploughing is necessary to a good crop of beet. Subsoiling is also required where there is anything in the nature of a pan.

Badly shaped, fangy roots mean waste in their cleaning and treatment at the factory, and a consequent loss in sugar. The grower is paid according to the sugar percentage, and it is to his advantage, therefore, to grow well-shaped roots, as well as a heavy crop. The loss from badly grown roots was very well demonstrated in some of the College trials, particularly where a portion of the roots had undergone "greening" by being forced above ground on shallow soils.

Farm manure, at the rate of 12 tons per acre, is a necessity when beet is grown after stubble, and should be ploughed in early in the autumn. Spring cultivations are similar to those for turnips, but a good depth of "frosty" surface mould is even more essential for a successful "braird" of beet than of turnips.

Seeds and Sowing.—Growers who are under contract in this country receive their seed from the sugar factory, and this ensures their getting seed of a true variety, with a guaranteed germination and sugar content. The amount of seed and the time of sowing are important factors in the success of the beet crop. An ample supply of seed—15 lbs. per acre at least—is required to ensure a sufficient number of quickly germinating seeds to give a good stand of young plants, and so to ensure a regular crop. The time of seeding will depend on the weather conditions and on the locality. Too early seeding in the north encourages "bolting," with a consequent loss of crop and sugar percentage. Probably a safe guide to the time of seeding would be to delay the operation until it is considered prudent to make the first sowing of swedes.

The best results in England and the Continent are obtained from drilling the seed on the flat, in rows 18 to 20 inches apart. The absence of suitable implements, both for the seeding and the inter-tillage of such narrow drills, has compelled growers in the north to use 24 and 26 inch ridge drills, and consequently the yields per acre have been less than would have been obtained from narrower drills. It is also held that wide drills encourage larger and coarser roots, with a lower sugar content. This would appear to be borne out by the result of the experiment at Cromarty, where the heaviest crop and the highest percentage of sugar were obtained in 1924 from 18 inch drills.

Manuring.—Beet responds to a liberal dressing of artificial manures, particularly nitrogen and potash, in addition to farm manure. Sufficient data are not yet available to enable the College to prescribe the best average dressing of artificial manures for the beet crop in the north of Scotland, but from such information as is available the following dressing per acre may be recommended:—

1 cwt. sulphate of ammonia.
3 cwts. superphosphate 35 per cent.
1 to 2 cwts. muriate of potash (or the equivalent of potash salt).
Also top-dress 1 to 2 cwts. nitrate of soda, as may seem necessary,—half the quantity before and half after singling.

Experiments are now proceeding to determine the most suitable quantities of the various manurial ingredients for the crop in respect to both weight of crop and sugar content.

Hoeing and Inter-Tillage.—Early "brairding," and early hoeing or singling, are necessary to ensure a satisfactory beet crop. To encourage the former, it is recommended that light rolling should be done a few days after seeding to consolidate the drills and bring the damp soil particles into close contact with the seed. In dry weather two, and even three, rollings may be necessary at this stage. After germination, growth may be hastened by light inter-drill harrowing, and this is strongly recommended. Singling should be commenced immediately the plants are readily distinguishable, and care should be taken to leave the best plant, and no doubles. Hoes with 7 inch blades are generally used to single the plants to a width of 8 or 9 inches. Delay in commencing singling means loss of crop to the extent of 2 to 3 tons per acre for each week of delay. This result was very marked in some of the College trials,

and in one case was the cause of almost complete failure. Inter-tillage should be started immediately after singling, fairly deep at first to aerate the soil and encourage downward growth, but shallower as growth proceeds, so as to avoid the risk of damage to the spreading root fibres, and consequent loss of crop. Experiments on the Continent have shown that the crop may be increased by 2 or 3 tons per acre by repeated inter-tillage operations. This is in keeping with the results obtained in the College experiments from repeated horse-hoeing of the turnip crop.

Harvesting.—The ripening of the crop is shown by the yellowing and flattening of the leaves. Growers who are under contract with a sugar factory are required to forward samples of beet for analysis at intervals as harvest time approaches. When the maximum sugar content is reached, intimation is sent to the grower and arrangements made for harvesting the crop. The beet crop is not readily damaged by frost, and when not required for sugar purposes may be left in the field throughout the winter without injury, although there is a loss of sugar by so doing. Beet sown in the middle of May should be ready for lifting in the beginning of November.

With small areas lifting may be done by hand with a beet fork, but when the crop extends to several acres a horse beet lifter is necessary. This implement loosens and raises the roots sufficiently to enable the workers readily to complete the lifting and topping. Workers quickly acquire the necessary skill and speed in these operations, as well as in collecting and preparing the roots for transport to the factory. It may be noted here that the fresh tops and crowns have a higher feeding value than equivalent weights of turnips. They may be fed to cattle or sheep in a fresh, clean condition, or made into silage. The value of the tops and crowns as green manure is approximately 11s. 6d. per ton. Judging from last year's trials, growers may count on a loss of 10 per cent. between the weight of the crop as lifted and the weight of washed roots at the factory.

Financial.—The chief consideration with the farmer in regard to the growing of sugar beet is—will it pay? There are not sufficient data at the moment from the North of Scotland trials to give a direct answer to the question, but from the estimate of the cost of production, which was prepared and published by Mr. H. H. Corner, B.Sc.(Agr.), County Organiser, from notes supplied by Mr. G. Butler, East Grange, Kinloss, one of last year's growers, and the contract terms for beet which are being arranged by the Highland Sugar Beet Syndicate this season, one can form a fair idea of what the financial returns are likely to be in the Moray Firth Districts.

Cost of Production of an acre of Beet—

	£	s.	d.
10 tons farm manure @ 7s. 6d.	£3	15	0
Artificial manures and seeds	2	7	6
Labour	6	1	6
Cartage to station, 1½ miles	1	10	0
Depreciation on implements	0	6	0
Rents, rates and taxes	1	15	0
Total	£15	15	0

Estimated Return from an acre of Beet—

9 tons beet containing 17·5 per cent. sugar @ 49s.	£22 1 0
Less additional carriage to nearest port .	1 10 0
Total . .	£20 11 0

These figures show a profit per acre of £4, 16s. Whether this shows a more profitable return than from other farm crops will be for each farmer to decide for himself, but it must be remembered that in the case of beet the price is a guaranteed one, whereas with other farm crops market prices fluctuate considerably.

There are other considerations of a financial nature to be noted in connection with the beet crop. The grower is sure of his market; he is paid for his crop on delivery after harvest; the residue of the crop is good feeding and manuring; and the cultural operations for beet improve the soil and increase the returns from other crops. A further consideration is the possibility of growers increasing the yield of beet by 2 or 3 tons per acre when they acquire greater knowledge and skill in the management of the crop.

Prospects.—Even with the increased acreage under crop in the Moray Firth Districts this season, the growing of sugar beet in the north of Scotland can hardly yet be said to have passed the experimental stage. But the prospects of establishing beet-growing as part of the present farm rotation are much brighter than they were twelve months ago. The greatly increased acreage of beet this season shows that farmers realise more clearly the possibilities of beet-growing. A local company—the Highland Sugar Beet Syndicate, Cromarty—has been formed to promote the industry, and has made satisfactory financial arrangements with the Orchard Sugar Factory, Greenock, for the purchase of this season's crop. The establishment of a factory in the Moray Firth District is also contemplated.

Experienced growers and factory owners in England and elsewhere hold the view that the growing of beet cannot be established as a paying farm crop until the farmer can deliver his beet at a local factory, thus reducing the cost of carriage to a minimum, and take home with him from the factory his share of the comparatively cheap beet pulp for stock feeding. It takes from 4000 to 5000 acres, producing an average of 10 tons of beet per acre, to keep a beet sugar factory profitably employed. Can this be done in the Moray Firth districts without unduly interfering with the present system of farming? It is a fairly large order, but by no means an impossible one. The soil and climatic conditions are suitable, and there is nothing to prevent farmers learning the science and art of growing sugar beet as thoroughly as they have done in the case of growing turnips and potatoes, and making such small adjustment in their green crop acreage as will give the necessary area to supply a local beet factory. There are about 50,000 acres devoted annually to turnips and potatoes in the coastal districts of the Moray Firth, and a tenth of this area could be devoted to beet without materially altering the present farm arrangements. If the present pioneers in the

movement can show that there is money in the business, there need be no doubt about getting the beet.

Lastly, beet-growing should appeal even more to the smallholder than to the larger farmer, as the crop is one that readily responds to the careful cultivation and constant attention which only the small grower can give. In their calculations, therefore, the promoters of the beet-growing industry should not lose sight of the smallholder. It is estimated that there are close on 2000 holdings of 20 to 60 acres in the Moray Firth districts, and were the smallholders' interest sufficiently aroused to the possibilities of the beet crop, it would not be surprising were 800 to 1000 acres of beet obtained from this source alone, and that would go a considerable way to aid the establishment of a local factory in the Moray Firth area.

THE EMIGRATION OF SCOTTISH AGRICULTURAL WORKERS.

J. M. Ramsay, O.B.E., M.A.

A good deal of attention has lately been given to the emigration of skilled workers from Scotland, and especially to that of agricultural workers. It may therefore be of interest to collect such figures as are available on the subject of post-war emigration, and also to make an estimate of the total amount of general emigration during the last two generations.

During the sixty years from 1861 to 1921 the "natural" increase of population in Scotland (*i.e.*, the excess of births over deaths) amounted to 2,794,000, while the actual increase recorded in the Census returns was 1,820,000. There was thus a net loss of 974,000 by "emigration," which includes migration to other parts of the British Isles. Allowance must, however, be made for immigration in the same broad sense. There were in Scotland in June 1921 (in permanent or temporary residence) no fewer than 416,000 persons born elsewhere (or about one in twelve of the whole population), of whom 194,300 were born in England and Wales and 159,000 in Ireland.[1] As no Census was taken in Ireland in 1921, and the "birthplace" figures for England and Wales have not yet been published, we take the figures for 1911. There were in that year in Scotland 395,000 persons born elsewhere, of whom 165,100 were born in England and Wales, 174,700 in Ireland, and 55,200 outside the British Isles.[2] On the other hand there were in England and Wales 321,800 persons, and in Ireland 38,500, born in Scotland.[3] Thus the movements between Scotland on the one hand and England, Wales and Ireland on the other were fairly well balanced, the net loss to Scotland being 20,500, which, set off against the influx of 55,200 from overseas, reduces it to 34,700. Assuming that this fairly represents the state of

[1] *Census Report, Scotland*, 1921, Vol. II, Table 50.
[2] *Census Report, Scotland*, 1911, Vol. II., Table XXXVIII.
[3] *Census Reports, England and Wales and Ireland*, 1911.

matters throughout the period of sixty years, we should have to make an addition to the 974,000 mentioned above in order to obtain the gross emigration from Scotland. It is, however, possible to analyse only the net figure of 974,000. The following table[1] shows that the tide of emigration was by no means uniform. The figures are given in thousands.

TABLE I.

Period.	*Natural Increase.*	*Actual Increase.*	*Loss by Emigration.*	*Per cent.*
1861–71	415	298	117	28·3
1871–81	469	376	93	19·9
1881–91	507	290	217	42·8
1891–1901 ...	500	446	54	10·7
1901–11	543	289	254	46·8
1911–21	360	121	239	66·2
Total ...	2794	1820	974	34·8

There were thus two periods of moderate emigration followed by two periods of heavy emigration having between them a period of very small emigration, when the annual loss was only 5400. These variations reflect broadly the ups and downs of Scottish industry and trade.

The last period, 1911-21, was rendered abnormal in this, as in every other aspect of our national life, by the occurrence of the Great War. The "natural" increase amounted to only two-thirds of that of the preceding ten years, owing to the losses of the war[2] and to the reduction in the birth-rate, and of this smaller number no less than two-thirds was lost by emigration, the proportion among male persons being actually three-fourths. Thus the net increase in the population of Scotland was the smallest on record since the Census of 1811 enabled such figures to be accurately given.

It is only since the year 1912 that precise records of emigrants and immigrants have been kept by the Board of Trade. Formerly the number was estimated by taking the differences between outgoing and incoming "passengers," but from April 1912 separate records have been kept of persons of British nationality proposing to take up permanent residence abroad and of immigrants of British nationality. These records of course exclude migration to and from other parts of the British Isles, save that two years ago, on the Irish Free State being constituted as a Dominion, movements between Scotland, England, Wales and Northern Ireland on the one hand and that State on the other were included.

The Board of Trade returns[3] give the following as the numbers of persons of British nationality who emigrated from or immigrated into Scotland each year from 1912 to 1923.

[1] *Census Report, Scotland*, 1921, Vol. II., p. vi.

[2] The deaths abroad of Scottish sailors and soldiers are estimated to have numbered about 74,000, exclusive of those which occurred in Scotland.

[3] *Board of Trade Journal*, Jan. 8th, 1925.

TABLE II.

Year.	*Emigrants.*	*Immigrants.*	*Net Emigration.*
1912 (April to Dec.)	57,000	10,150	46,850
1913	68,200	13,950	54,250
1914	34,300	16,500	17,800
1915	10,100	14,450	-4,350
1916	8,300	8,000	300
1917	1,100	1,300	-200
1918	1,100	1,000	100
1919	16,800	12,350	4,450
1920	48,500	10,300	38,200
1921	41,400	10,600	30,800
1922	39,900	9,000	30,900
1923	88,600	8,500	80,100
Total ...	415,300	116,100	299,200

It will be seen that the heavy emigration of the period 1901-11 continued up to the outbreak of war, when the stream almost ceased. The year 1919 showed a small number, and those for the years 1920 to 1922 were considerably under those for 1912 and 1913, but a great increase took place in 1923.

In order to test the figure already given for the period 1911 to 1921, we allow 60,000 for the year from April 1911 to March 1912 and 20,000 for the 5½ months from January 1921 to the date of the Census. Adding these to the total for 1912 to 1920 as given in the table, 157,400, we obtain about 237,000, which agrees very closely with the 239,000 already given; this shows that the movements between Scotland and the rest of the British Isles must have almost exactly balanced one another.

Coming now to the question of the emigration of agricultural workers, we find that details are apparently available only from the year 1921, when a classification of emigrants of British nationality by occupation was undertaken. This classification applies to all persons over 18 years of age, and in the published tables[1] males are divided into ten groups and females into six. The total gross number of emigrants from Scotland in the three years 1921 to 1923 was 169 900, and of these 123,070 were over 18, of whom 78,140 were men and 54,930 were women.

The occupations of the men were as follows:—

TABLE III.

Occupations.	*Number.*	*Per cent.* A.	*Per cent.* B.
Agricultural	10,550	13·5	10·5
Commercial, etc.	7,775	10·0	11·1
Professional	2,300	3·0	2·3
Mining and Quarrying ...	6,600	8·5	11·5
Metal and Engineering ...	20,730	26·4	23·0
Building	2,700	3·5	4·3
Other skilled trades	11,875	15·2	...
Transport and Communications	3,170	4·0	9·7
Labourers not in Agriculture or Transport	6,510	8·4	...
Others	5,930	7·5	..
Total	78,140	100·0	...

[1] *Board of Trade Journal*, Aug. 28th, 1924.

The first column gives the actual number, the second the percentage that that number bears to the total, and the third the percentage that the group in question bore to the whole number of "occupied males" in Scotland at the time of the Census in 1921, so far as the grouping corresponds. A comparison between percentage 'A' and percentage 'B' shows how far emigration among men of any group was above or below the average. On the whole, the emigrants appear to have been a pretty fair sample of the working male population. Of the groups for which a comparison can be made, Transport, Building and Mining and Quarrying contributed considerably less than their quotas, and Commercial, etc., somewhat less, while the Professional, Agricultural and Metal and Engineering groups contributed more than their quotas. In the case of agriculture, the exact quota would have been 8200; there was thus what may be called an excess emigration of 2350.

It may be suggested that the Agricultural group includes many crofters' sons, for whom no holdings were available in the congested Western Islands. These emigrants cannot, therefore, be regarded as lost to the Scottish agriculture in the same sense as ploughmen or other skilled workers on farms. But any adjustment on this account would have to be accompanied by a corresponding adjustment of the Agricultural group in the Census returns, on which the quotas referred to above are based. Thus it remains true that Scottish agriculture has in recent years been depleted by emigration above the average of all industries, though not to an excessive degree.

A very different result is reached by an analysis of the figures relating to England and Wales. Emigration from these countries during the years 1921-1923 was relatively much less than that from Scotland, the total gross number of male emigrants over 18 being 161,550, or little more than double the Scottish total, whereas the proportional number would have been eight times the latter. But out of the English total the Agricultural group accounted for 31,550, or 19·5 per cent., and was both absolutely and relatively the largest of the ten groups. Its quota would have been only about 13,000.

While the emigration from Scotland of men over 18 increased in 1923, as compared with 1921 and 1922, by an even larger ratio than that shown in Table II. for all emigrants, the proportion of agriculturists showed little variation, the figures being as follows:—

TABLE IV.

Year.		*Male Emigrants over 18.*	*In Agricultural Occupations.*	*Per cent.*
1921	... ...	14,860	2,150	14·6
1922	... ...	17,030	2,200	12·9
1923	... ...	46,250	6,200	13·4
	Total ...	78,140	10,550	13·5

The gross figures of emigration have been used in all these statements. The total number of immigrants of British nationality in agricultural occupations into the British Isles during the years

1921-23 was 7500. Thus the gross number of emigrants of this class was reduced from 52,600 (England and Wales, 31,550; Scotland, 10,550; Ireland, 10,500) to 45,100; but the published tables do not show how many came into each country.

An analysis of the destinations of the agricultural emigrants shows that 7150 went to Canada, 2600 to other parts of the Empire, and only 800 to foreign countries. Out of the 20,730 emigrants in the Metal and Engineering group, on the other hand, 13,380 went to the United States.

Little attention need be given, from an agricultural point of view, to the classification of the 54,930 female emigrants over 18 years of age. The largest groups were "wife and housewife," 26,700, "domestic and other service," 13,020, and "other and ill-defined occupations," 6670. The three remaining groups of defined occupations included 8540, none of whom were agricultural.

The conclusion expressed above, that agriculture has not been unduly depleted by emigration, is based only on the detailed figures for the years 1921 to 1923, and so far as these years are concerned it is confirmed by the returns collected annually by the Board of Agriculture for Scotland, which exclude occupiers of holdings but include members of their families.

The figures are as follows :—

TABLE V.

	Regular Male Workers.		
Year.	*Over 21.*	*Under 21.*	*Total.*
1921	58,810	23,290	82,100
1922	58,600	22,920	81,520
1923	57,560	22,880	80,440
1924	58,010	22,075	80,085

The figures obtained in 1908 and 1913 show, however, that a large decrease took place between 1908 and 1921. The age-grouping then adopted was "over 18" and "under 18," and the following are the numbers :—

TABLE VI.

	Regular Male Workers.		
Year.	*Over 18.*	*Under 18.*	*Total.*
1908	90,000	29,000	119,000
1913	80,300	21,300	101,600

If the returns are truly comparable, it appears that the total number of regular male workers was less in 1921 than in 1908 by nearly 37,000, and a large proportion of this loss was no doubt due to pre-war emigration.

MINERAL NUTRIENTS IN THE RATIONS OF DAIRY COWS.

J. B. ORR, A. CRICHTON, J. A. CRICHTON and W. MIDDLETON.
From the Rowett Research Institute.

DURING the last few years an investigation on the mineral requirements for milk production has been proceeding at this Institute. Although the results so far obtained here are not sufficiently extensive to form a reliable guide in feeding, they fall into line with the results being obtained at certain experimental stations abroad, and as there is an increasing number of dairy farmers and cake manufacturers who are seeking information on this subject, it is thought that the present note stating the nature of the problem being investigated, and giving an indication of the nature of the results being obtained, may be of interest.

It has been definitely proved that in heavy milking cows, which are stall-fed on rations commonly used, the output of some of the mineral elements in the milk and excreta is usually greater than the intake in the food. There is consequently a loss of these elements from the body during a large part of the lactation period. So far as is known, the elements of greatest importance in this connection are calcium (lime), phosphorus, sodium and chlorine. It is believed, however, that there is sometimes also a depletion of certain other mineral elements.

A temporary loss of these substances from the bodies of lactating animals is probably a natural phenomenon, for which provision is made by storage during the later stages of pregnancy. For a cow living under natural conditions, feeding on pasture and providing only the two or three hundred gallons of milk required to rear a calf, a slight loss of minerals, if it does occur, is of no consequence. But under modern conditions of intensive milk production, there are certain factors which may make this loss of minerals during lactation so large that the health and consequently the milk-producing capacity of the cows may be affected. Three of these factors may be considered.

The efforts to breed heavy milkers have been so successful that some cows have now the capacity to produce more than ten times the amount of milk required to rear a calf. The output of minerals in the milk is correspondingly increased.

Most of the foodstuffs used in intensive modern feeding are relatively poorer in calcium, sodium and chlorine than ordinary mixed pastures. The following figures taken from a previous paper (1) compare the amount of these elements (in ounces) present in 100 lbs. of a good mixed pasture, and in a winter ration of turnips, straw, draff (distiller's grains) and concentrates of roughly equal starch values.

	Calcium Oxide (lime). Ozs.	*Sodium Oxide.* Ozs.	*Chlorine.* Ozs.
Pasture . .	5·8	3·7	5·1
Winter Ration	2·2	1·9	1·6

In recent years there has been a tendency towards increased milk production in winter. There is therefore, during the winter

months, when the animals are confined to stalls, a heavy drain of minerals from the cow's body at a time when it does not receive the beneficial influence of sunlight and exercise, both of which, especially the former, have been shown to be important factors in increasing the percentage of calcium which can be absorbed from the food and therefore made available for milk production (2).

Hence, under modern conditions, with cows pressed for a high milk yield, fed on a diet liable to be deficient in certain minerals and kept under conditions in which the greatest use cannot be made of the minerals which are present in the food, there appears to be a danger of the cows suffering a serious depletion of these minerals from their bodies.

Now the results of feeding experiments with small animals have shown that, following privation of some of the mineral elements, pathological conditions arise, and there are various diseases attributable to deficiencies of mineral matter in the food which sometimes arise in ordinary practice, especially in districts where the soils are of abnormal composition. A number of these diseases have been described by Hutyra and Marek (3).

In connection with cattle, it has been proved by Hart, Steenbock and Humphrey (4) that deficiency of calcium in the ration may be the cause of the failure of cows to produce healthy calves. The results of carefully conducted tests showed that cows on rations markedly deficient in calcium tend either to be sterile or to breed weak calves, while perfectly healthy calves were born from the same cows after the ration was improved by the addition of calcium.

Fingerling (1911) found that cows on rations poor in calcium fall off in their milk yield more rapidly than when their rations are rich in calcium, and more recently Meigs of the United States Department of Agriculture and Erf of Ohio University found that milk production can be increased and better health maintained by the addition of inorganic salts to rations in which they are present in insufficient amounts (5).

It has frequently been noted that common salt (sodium chloride) improves the condition of cattle. An experiment by Babcock and Carlyle (6) at Wisconsin Experimental Station (1905) showed that deficiency of chlorine affected both the yield of milk and the health of cows. When chlorine, in the form of sodium chloride (common salt), or potassium chloride was supplied to cows which were in a state of malnutrition due to deficiency of chlorine, there was a rapid recovery in health.

Such information therefore as is available seems to suggest that heavy milking cows may be liable to suffer a depletion of mineral elements from the body to such an extent that the milk yield is restricted and the animals or their offspring suffer in health.

At first sight it might be thought that the problem of the mineral requirements of dairy cows could be easily solved merely by adding inorganic salts to the ration, and that the value of the adjustment would be seen by an immediate improvement in health or milk yield. In the case of deficiency of chlorine, an immediate effect can be observed. The problem of the calcium supply is, however, more difficult. It has been shown by Forbes of Pennsylvania State College (7) that the loss of calcium during

lactation cannot be entirely prevented by adding calcium salts to the ration. This is because there are certain dietary factors which affect the percentage absorption of the mineral elements from the intestine. One of these factors is the proper balance of all the constituents of the diet. Thus there might be sufficient calcium in the diet, but owing to a relative deficiency of the other mineral elements the maximum amount of calcium could not be absorbed and utilised. The proportion of protein and fat in the diet also affects the percentage utilisation of the mineral elements. The problem of adjusting a ration to ensure that a dairy cow will have sufficient of all the essential mineral elements is, therefore, not solved merely by an arbitrary addition of any one of the elements. It is necessary that the whole ration should be so constituted that all the elements are present in sufficient amounts, and so balanced that the necessary amounts can be absorbed and utilised.

It is necessary to refer here to short tests in which for a few days or weeks some mineral salt was added to the ration, and the effect on milk yield noted. In an investigation carried out by Lauder and Fagan of Edinburgh (8), it was found that the addition of calcium phosphate had no immediate effect on the daily volume of milk produced; Taylor, working at this Institute with goats, in 1920, and more recently M'Candlish and Berry (9) of Kilmarnock working with cows, obtained a like result. This recent work confirms what has been observed by earlier workers. The addition of bone meal, calcium phosphate or chalk has no immediate effect in increasing the milk yield. Indeed if too much be added there is likely to be a decrease in the yield.

The results of these short tests is just what might be expected. It is known that the cow will continue to produce milk even though she is suffering a net loss of mineral nutrients from her body. Hence an increase in the intake of these minerals is unlikely to have an immediate effect in increasing the yield of milk. Whatever effect is produced will be in the direction of decreasing or stopping the loss from the body, and so postponing the time when the reservoirs will be exhausted. If, therefore, the addition of minerals to the ration has any effect on milk yield, the effect will be shown in a greater yield in the later stages of lactation or in a greater yield in a subsequent lactation period.

It is obvious from what has been said above that, if the infiuence of mineral additions to the ration on the milk yield is to be decided, it is necessary that all the mineral nutrients deficient in the ration be supplied in, as far as can be estimated, the amounts required, and also that the test be carried through several lactation periods on the same cows. There is difficulty in fulfilling completely the first of those conditions because we do not know the proportions of the necessary minerals required to ensure the maximum assimilation of each, nor do we know all the factors which determine what percentage of the minerals can be assimilated. The best that can be done is to make a more or less arbitrary addition of such elements as are thought to be present in insufficient amounts, and carry the tests over three or four lactation periods. The experiment referred to below is an attempt to carry out a test on these lines.

Experimental Data.—As it is intended to give a further and fuller report of these experiments at a later date, it is sufficient for the purposes of this paper to give a general idea of the nature of the experiment and the results obtained to date.

Twelve pedigree Ayrshire heifers (negative to the tuberculin test) were selected with, as far as could be ascertained, approximately equal inherited capacity to produce milk. All calved between November 1922 and January 1923. The ration fed consisted of oat straw *ad lib*, turnips or silage (six cows on silage and six on turnips), draff, and a compound cake consisting of equal parts of rice meal, palm kernal cake, decorticated ground nut cake, wheat offal and molasses.

The roughage of this ration, *i.e.*, the oat straw, silage and turnips, has probably sufficient of most of the essential mineral nutrients required for maintenance purposes. The draff and the cake were, however, relatively deficient in calcium and chlorine, and to a less extent in sodium. It was thought that the cake might also be deficient in iron and iodine. The cake for half of the cows was therefore fortified by the addition of 56 lbs. carbonate of lime, 28 lbs. common salt, 1 lb. iron oxide and 2 ozs. potassium iodide to each ton of cake. The consumption of cake for each cow was regulated according to her milk yield. The other parts of the ration were kept constant. One half of the cows on turnips and one half of those on silage were given the cake with the added minerals, the others were given the cake without this addition. There were thus four groups of three cows as follows:—

1.	2.	3.	4.
Silage ration.	Silage ration plus minerals.	Turnip ration.	Turnip ration plus minerals.

In all the groups the cows were allowed sodium chloride in the form of "salt lick," which was fixed in the stall and renewed when necessary.

The rations were fed for seven months in the year during which the animals were inside. In the five summer months the animals were allowed to graze together. During the time they were grazing the feeding of cake was continued throughout at a lower level than in winter. Every six months the tuberculin test (subcutaneous method) was carried out. Table I. gives the average yields and lengths of lactation periods for the four groups for the first and second lactations.

Results.—(a) *Milk Yield.*

TABLE I.

	Average yield per cow.		Increase or Decrease.	Length of 1st Lactation.	Length of 2nd Lactation.
	1st Lactation.	2nd Lactation.			
	Lbs.	Lbs.	Lbs.	Weeks.	Weeks.
Silage ration . .	9,556	8,566	−990	50·1	39·6
Do. + minerals	10,207	10,355	+148	50·7	43·7
Turnip ration .	11,843	10,149	−1,694	60·6	42·8
Do. + minerals	9,851	10,103	+252	52·5	42·5

Table II. compares the average total milk yield of the six cows receiving extra minerals with the yield of the other six.

TABLE II.

	1st Lactation. Lbs.	*2nd Lactation.* Lbs.	*Increase or Decrease.* Lbs.
Silage and Turnip Rations	10,699	9,358	−1341
Do. + minerals	10,029	10,229	+200

It will be seen that on the average the cows on the ration plus minerals increased their yield in the second lactation as compared with the first, whereas those in the "non-mineral" groups decreased their yield.

(b) *Calves.*—All the cows have bred successfully. The average weight of the calves at birth in the two groups has been as follows:—

	1st Calves. Lbs.	*2nd Calves.* Lbs.
"Non-mineral" Group . . .	83·2	77·8
"Mineral" Group	81·3	82·6

In the "non-mineral" group the average weight of the 2nd calves is much less than that of the first. In the "mineral" group the average weight of the second calves is higher.

(c) *Health.*—It is thought that the cows in the "mineral" group have been throughout the experiment in better condition with regard to coat and thriftiness than those in the "non-mineral" group, and that the difference has been most marked at the end of the winter periods. Too much importance should not, however, be attached to these observations as they cannot be reduced to figures which can be compared. The more definite findings as regards health are as follows:—

In four of the six cows in the "mineral" group after the birth of the 2nd and 3rd calves, there was marked delay in cleansing. In one of these cases of delayed cleansing the calf was born dead. No such difficulty in cleansing was observed after the birth of the first calves, *i.e.*, before the mineral cake was fed, and no abnormality in cleansing was noted in the "non-mineral" group. Apart from this difficulty in cleansing, the six cows in the "mineral" group have remained in perfect health, and seemed to be in excellent condition at the end of each seven months' period of winter feeding. In all these six cows the tuberculin test gave negative results at each of the five half-yearly tests which have been made.

In the "non-mineral" group, No. 1 has reacted three times to the subcutaneous tuberculin test; No. 2 has suffered each winter from a condition which suggests the early stages of osteomalacia. The condition becomes progressively worse during the winter periods, at the end of which, when put out to pasture, she has on each occasion been so crippled that she walks with difficulty. On pasture the condition markedly improves; No. 3 has reacted once to the tuberculin test and has become rather emaciated and her 3rd calf was born dead; No. 4 has shown no signs of malnutrition; No. 5 reacted to the tuberculin test four times; No. 6 has suffered

from several attacks of mastitis (inflammation of the udder). Thus only one cow out of the six has shown no sign of disease or malnutrition.

Discussion of Results.—The average milk yield and the average weight of the calves born tended to increase in the 2nd lactation in the case of the cows in the "mineral" group, whereas in the case of the cows in the "non-mineral" group there was a decrease. The health of the animals in the "mineral" group was, with the exception of the delay in cleansing, better than that of the cows in the "non-mineral" group. It should be emphasised that too much importance should not be attached to these results. The number of animals is too small to give average figures which would be reliable, and the results of the subcutaneous tuberculin tests are of doubtful value. Even though the tests were done with the greatest care, the results have been inconstant even in the same animal. Some, after giving a positive reaction, give a negative reaction at a later test. On the whole, all that can be said is that the available evidence seems to indicate that the addition of the minerals has had a beneficial influence on the health of the animals and has tended to maintain or increase the milk yield, and that probably an excess of some constituent in the mineral mixture has had an adverse effect on the process of cleansing. Taken in conjunction with the results obtained by such workers as Fingerling, Meigs and Erf, the results of the tests afford grounds for the view that the mineral content of the ration for dairy cows is an important factor for milk yield, and probably an even more important factor for the health of the animals. The present test being carried out by us will be, if possible, continued for other two lactation periods to ascertain whether the differences in milk yield and in health in the two groups become accentuated as the number of lactation periods increases, and to confirm, or otherwise, the effect of the addition of the minerals on the process of cleansing In the further tuberculin tests the intradermal method will be combined with the subcutaneous.

It is necessary to point out that neither the composition of the cake nor the mineral mixture used in these experiments is to be taken as any guide in practice. The former was used merely because it was cheap and suited the purpose of the experiment; the latter was an arbitrary mixture, which will be altered in subsequent experiments. Indeed it is not suggested that the results of these tests are at this stage of any immediate practical value, except in so far as they point to the desirability of tests being carried out under practical conditions. If there is even the possibility of a beneficial effect on the health of cows being obtained by balancing the mineral content of the ration, which can be easily and cheaply done, it seems to be worth while carrying out a number of tests under practical conditions. The results of such tests would form a guide to milk producers.

Summary.—Evidence from previous investigations has been brought forward to show that the mineral content of the ration is an important factor in maintaining health in milk cows, and also indirectly in maintaining the maximum milk production of which cows are capable.

A preliminary report has been given of an experiment with twelve dairy cows, six of which were fed on an ordinary ration and six on the same ration with the addition of certain minerals considered to be deficient. The results, although insufficient to lead to definite conclusions, suggest that it is possible by making additions of minerals to rations to improve their nutritive value. The mineral ration showed a beneficial effect both on the health of the cows and on the milk yield. But there is also evidence that the addition of a mineral mixture to a ration may have a detrimental effect.

The necessity for further experimental work to furnish a guide to practice is emphasised.

NOTE.—*We wish to express our indebtedness to the Ayrshire Cattle Herd Book Society, who made a grant to assist in the purchase of the cows used in these experiments, and whose president for* 1922-1923, *Mr. Adam Montgomerie, gave valuable help in obtaining the right type of animals required for the experiment. We are also indebted to a well-known English cake manufacturing firm for preparing and supplying free of charge the cake used.*

REFERENCES.

1. Orr.—Trans. Highland and Agri. Soc., 1924.
2. Hart, Steenbock and Elvehjem.—J. Biol. Chem., vol. 62, 117, 1924 ; and Orr, Magee and Henderson.—J. Physiol. (Pro.), vol. lix., 1924.
3. Hutyra and Marek.—Special Path. and Ther. of Diseases of Domestic Animals, 1913.
4. Hart, Steenbock and Humphrey.—Res. Bull. 49, Wisconsin Agric. Exp. Stat., 1920.
5. Proceedings of the World's Dairy Congress, pp. 1046 and 1055.
6. Babcock and Carlyle.—Wisconsin Report, 1905.
7. Forbes.—Proceedings of the World's Dairy Congress, p. 1036.
8. Lauder and Fagan.—Pro. Royal Soc. (Edin.), vol. 35, part II., 1915.
9. M'Candlish and Berry.—Scot. J. Agric., vol. viii., 1925.

Reviews.

Cattle-Breeding: Proceedings of the Scottish Cattle Breeding Conference. Edited by G. F. Finlay, Ph.D. Published by Messrs. Oliver & Boyd, Edinburgh.

Not the least useful outcome of the Scottish Cattle Breeding Conference, held in Edinburgh in July 1924, is the published account of the proceedings recently issued under the editorship of Dr. Finlay, secretary to the Conference. Even the strongest mental digestion could hardly cope with such a feast of data, accounts of scientific and practical experimental work, and theoretical explanation, all in the course of the six days of the Conference. But with the papers collected into permanent form, the student of breeding problems will be able to read, mark and digest at leisure.

In a foreword Sir Robert Greig, the president of the Conference, points out that the book embodies the most recent knowledge on many aspects of cattle breeding and thus appeals alike to the scientific worker, the expert breeder, the agricultural teacher and the student. "As a stimulation to thought, to further striving

after knowledge, to deeper and more fundamental research, this book will stand."

The range of subjects dealt with is wide, embracing palæological, antiquarian and historical investigation on the origins of cattle and of breeds; discussion of genetical principles and their relation to problems of practical breeding; explanation of sex determination; consideration of the questions of in-breeding, family and line-breeding and selection; and, apart from these highly technical papers, there are also discussions of such practical problems as live-stock judging, breed, show and market standards, performance standards and progeny tests; the advanced registry system popularised by the Holstein-Friesian Association in America, and the interpretation of milk records.

Part II. is taken up with reviews of investigations which have been made in various specific problems of cattle breeding, and Part III. gives authoritative accounts of the establishment of different breeds in other countries, such as the shorthorn in America, the milking shorthorn in Australia, Africander cattle, the cattle of Canada, Nigeria and Japan; and concludes with a review of the world situation and prospects in respect of the supply of cattle.

When it is remembered that each of these and the numerous other topics is handled by an acknowledged authority on the subject, it will be recognised that the publication is one with which no one interested in cattle breeding can afford to dispense, and the promoters of the Conference, and especially the secretary and editor, Dr. Finlay, are to be congratulated on this excellent record of the proceedings.

Animal Genetics: An Introduction to the Science of Animal Breeding. By F. A. E. Crew, M.D., D.Sc., Ph.D., F.R.S.E., Director, Animal Breeding Research Department, Edinburgh University.

An interesting series of monographs on Biological Science by workers in this field is in course of publication under the general editorship of Dr. Crew, Edinburgh, and Dr. D. Ward Cutler, Rothamsted, the publishers being Messrs. Oliver & Boyd, Edinburgh. The aim of the series is to provide authoritative accounts of recent advances in biological investigation, and to relate these on the one hand to previous knowledge, and on the other to problems that still remain to be solved; and the intention is to include not only pure biological research, but also the application of biological principles to economic problems.

Included in the series is the treatise under notice. In his introduction Dr. Crew makes out a strong case for appreciation by the stockbreeder of the advances which have been made in recent years by biologists in the direction of scientific explanation of many points in breeding practice. He gives generous recognition to the results obtained by breeders of the past who set up a standard of quality and worked towards it by a long process of trial and error, attaining thereby a wonderful measure of success. But what these improvers did empirically, the breeder of the future, equipped with the knowledge which the science of genetics will in time furnish him with, will plan and carry through with the accuracy of a mathematical demonstration. The present

state of knowledge in genetics is clearly set forth by Dr. Crew, whose exposition of the theories of heredity advanced by different authorities is comprehensive and interesting. The genetical terms now in use are carefully explained, and, while the whole argument is by no means easy reading, the serious student will be greatly helped by these explanations, by the examples quoted from practice and by the numerous excellent illustrations.

Besides giving a full statement of the modern theory of heredity, Dr. Crew deals specially with a subject that he has made peculiarly his own—that of sex determination, its mechanism, its physiology and its control. In-breeding and out-breeding and the relations of heredity to fecundity and fertility and to disease are carefully studied An interesting chapter is taken up with disputed beliefs, such as telegony, maternal impressions affecting the offspring, reversion, and transmission of acquired characters. The usefulness of the book is greatly enhanced by a list of references to other publications and by a full bibliography.

Collected Papers, Volume I.: The Rowett Research Institute.—This volume constitutes a record of valuable work on which any research institute, but particularly one of such recent birth as the Rowett, might well be congratulated. Of the 62 papers which the volume contains, 2 were published in 1914 and all the rest within the last five years, the research work having been entirely suspended during the war. An average output of one paper per month may seem, on the face of it, a heavy yield for a scientific soil to bear, but there is no evidence that the director or any member of the staff has yielded to the temptation, not unknown in the world of research, of hurrying to market with immature or ill-gathered crops. All the work described has been skilfully planned and executed, and the results are stated with a moderation and an absence of dogmatism of which the most cautious scientist would approve. The papers, of which 11 have appeared in this Journal, are very varied, both in subject and in style. Some, which have been published in the purely technical periodicals, will appeal mainly to the scientific specialist, while others are either semi-popular expositions of matters of direct practical interest or statements of experimental results capable of commercial application by the farmer. The field of research in animal nutrition is a wide one and a difficult one to till; these papers show that the work of the Institute has been well begun and give promise of good harvests in the future. Copies of the volume, price one guinea, may be obtained on application to the secretary of the Institute.

THE following article has been contributed by Mr. J. Evans Gordon, Edinburgh and East of Scotland College of Argriculture.

Agricultural Education in West Lothian.

The problem of the teaching of Agricultural Science in day schools is one which has been occupying the attention of not a few authorities for quite a number of years. In view of the fact of interest being further awakened by the report of the Departmental Committee on the General Organisation and Finance of

Agricultural Education and Research in Scotland (1924), this brief review is written in order to indicate the line of development being taken by one particular county, namely, West Lothian.

The development of agricultural instruction in schools in West Lothian resolves itself into three stages. For a considerable number of years the subject of Nature Study has been looked upon as a very valuable item in any school curriculum, and it has found quite an important position among the numerous subjects taught to infant, junior and advanced classes in both elementary and secondary schools; but the subject has been treated from a general standpoint, except where in more advanced classes special attention has been paid to the needs of intending teachers or intending University students.

From this general Nature teaching evolved the more definite course of instruction in School Gardening. This course was characterised by concentration on the crops of the garden and on the natural botanical orders, and by the selection of schools which could provide suitable ground in which to lay down plots. Although the scheme served a valuable purpose, the tendency was to convert it into a rigid system of rotational cropping without dealing with the scientific principles on which growth depends.

In the next stage of development an attempt was made to remedy this defect by establishing a laboratory, in which were taught, experimentally, the principles of physics, chemistry and agriculture. The school garden scheme was modified for the purpose of applying these principles and investigating problems which from time to time might arise. The difficulties of obtaining laboratory equipment and of getting teachers qualified to teach physics and chemistry were surmounted by establishing courses at schools which were already being used as central schools and which had provision for instruction in practical subjects. Rural Science thus became a special course at a central school which possessed the necessary equipment and land. One outstanding feature throughout the new development was the recognition of the necessity for closely dove-tailing together all the subjects of practical instruction. The course was designated a two years' course in Rural Science, including both laboratory experiments and practical work on the school plots.

This third stage of development was the outcome of a conference convened in February 28th, 1924, by the Edinburgh and East of Scotland College of Agriculture. As a result of that conference a course for advanced divisions in rural schools was recommended and the following curriculum was suggested:—English (including History and Geography), Mathematics (including Arithmetic and Mensuration), Art, Rural Science, Handicraft (Boys), Domestic Science (Girls), Music, Physical Training. This syllabus has been adopted with marked success in three schools in West Lothian. It allows for a three years' course in Rural Science leading up to the new National Certificate, and in two schools, namely, South Queensferry and Winchburgh Public Schools, five pupils were examined in Rural Science last February.

Three types of pupils are recognised. There is first the pupil who will leave school and return direct to the land. The course

in Agricultural Science aims at giving this pupil a valuable general training, at the same time laying the foundation of more specialised courses of study to be taken up later in evening continuation classes.

A second type presents itself in the pupil who desires to go beyond an elementary school education. He should follow a course leading up to the National Certificate, and this would qualify him for admission to a Central Institution.

Thirdly, there is the pupil who will desire to go forward for an academic training in order to qualify for an ordinary or an honours degree of a University. The elementary school career, in this case, would require to be supplemented by a period of instruction at a secondary school leading up to the Higher Leaving Certificate or the Preliminary Examination for entrance to a University. From this class would be supplied teachers of Rural Science, who would require to undergo a training at a recognised Teachers' Training College. This class would also supply men for accurate experimental work, lecturers, recorders, inspectors and research workers.

It is thought that the above objectives can be reached by the following system, which is at present being used:—

1. The pupils in the primary school begin with elementary lessons in Nature Study.
2. In the pre-qualifying stage they receive instruction in the elements of Rural Science.
3. The post-qualifying or advanced division take the three years' course.

The course now being conducted at South Queensferry includes instruction in Agriculture and Horticulture, and at Winchburgh, Agriculture, Horticulture and Poultry-keeping. The instruction embraces classroom work, laboratory exercises and work on the plots.

In the classroom the agricultural science teaching is given with the aid of the blackboard, charts, diagrams, photographs, models and lantern slides. Some efficient system of recording the lesson must be used and note books are carefully kept. Care is taken to ensure that the work is closely correlated to all subjects in the course.

The laboratory work is purely experimental, indicated and directed by the teacher and carried out by the pupils. In order to secure really good work, it has been found necessary that the laboratory equipment be thorough. It is not suggested that all the apparatus should be purchased, because part of the training consists of the improvisation of apparatus, and by this method quite an elaborate stock of apparatus can be worked up either for temporary or for permanent use. Plenty of working space and cupboard accommodation is essential, and a system should be devised whereby individual pupils or groups of pupils have lockers for storage of pieces of apparatus constantly in use or being used during the period of an experiment. This serves to train the pupil in system, cleanliness and responsibility. It is in this section of the work that the pupil is shown how to make deductions, formulate ideas and apply these.

Besides experimental work in the science room other lines of work are followed. Weather studies form a very necessary part of the instruction. Various pieces of apparatus are installed on the plots, such as thermometers—maximum and minimum, wet and dry; wind vane for wind direction; anemometer for wind velocity; daily and monthly rain gauges. The barometer is accommodated in the laboratory, where all readings are recorded and graphical representations of weekly, monthly or annual series of readings are made and filed for reference. Instruction in the theory of weather science is also given. Reports on weather observations and on the results of small experiments conducted from year to year on the school plots are occasionally submitted to the press for publication. The writing of short essays on subjects connected with agriculture is encouraged, but more from the pupil's own standpoint, and as an outcome of his private reading.

It has been found of considerable value to institute a photographic section for the purpose of making permanent pictorial records of experiments in the science room and on the plots. This leads up to the school museum, the advantage of which is obvious. By encouraging pupils to collect specimens of rocks, soils derived from particular sources, plants, insects and the like, a methodical collection can be laid out which will prove of great educational value not only to the Rural Science Course but to the whole school. A reserve supply of specimens for class purposes can thus be in readiness at all times.

Work on the school plots is the third section of the Rural Science Course. This part of the instruction is closely correlated to class room and laboratory work. It is on the plots that all principles are applied, and there fresh problems arise for investigation in the laboratory. It is desirable that the plots be near to the school, that they should have a suitable exposure and soil type and be of convenient size. The lay out of the plots allows for a poultry run, a horticultural and an agricultural section.

The poultry run is used for the study of poultry housing, breeds, rearing, feeding and management. Diseases and other subjects are dealt with in the classroom.

The horticultural and agricultural plots are laid out for the purpose of studying cultivations, rotational systems, crops, manuring, seed sowing and diseases in relation to all types of garden and farm crops. A conveniently sized tool shed with an adequate supply of tools is provided.

Poultry-Keeping on a Small-Holding under the Edinburgh and East of Scotland College of Agriculture.

THE following notes, which have been contributed by Miss Bremner, Edinburgh and East of Scotland College of Agriculture, show what has been done in the way of developing poultry-keeping on a 45 acre holding in Berwickshire.

The place was taken over as a demonstration holding in December 1920, and is run chiefly for milk production. In December 1921 it was decided that some definite system of poultry-keeping

should be adopted. About 20 fowls were already on the holding and from these the instructress selected 16 Light Sussex, as this was the breed the small-holder's wife wished to keep. The intention was to increase the stock gradually up to 100, as it was considered that this was as many birds as could be looked after, having regard to the other work on the farm. The best of these birds were mated to a cockerel from a well-known laying strain, and from this small pen the whole of the stock has been built up. By the end of the first year the stock had been increased to 50 head, and by the end of the third year the maximum number of 100 birds had been reached. No eggs were sold for setting until the third year, so that the returns shown below are from eggs sold at ordinary market price.

	Receipts from Eggs and Fowls.	*Cost of Food.*	*Gross Return.*
1922 . . .	£31 6 6	£17 8 10	£13 17 8
1923 . . .	50 12 6½	23 9 11	27 2 7½
1924 . . .	101 0 5½	38 19 10	62 0 7½

In the management of the birds everything is done to save labour, and care is taken to avoid waste in feeding, home-grown products being used when available. After harvest the fowls are placed on the stubble, where they pick up almost sufficient food for themselves, only fresh water and grit being supplied and a small feed once a day. During the winter months the birds are brought in from the open fields to as sheltered a place as possible. A scratching shed has been erected near the houses for shelter in stormy weather. It is littered down with straw to a depth of about six inches, and the grain is buried in the litter. A marked increase in the winter egg yield was noticed immediately after the erection of this additional shelter. A liberal supply of turnips is given throughout the winter, which helps to make up for the lack of grass.

From 30 to 50 pullets are to be raised each year to replace the birds which are disposed of at two and a half years old. It has not been thought necessary to purchase an incubator, as the birds which are not up to the required standard for the breeding pen are used as broodies.

It has sometimes been stated that the Light Sussex is not a profitable breed to keep, but on this holding, where no expense has been spared in securing the best laying strains, the egg yield compares very favourably with even the White Leghorn, while the price obtained for the young cockerels and old hens fully justifies the choice.

Average price per dozen obtained for eggs:—

	s.	*d.*
1922	2	4
1923	1	9
1924	1	10

As yet, trap nesting has not been adopted, but it is hoped that this may be done in the future.

Accurate accounts are kept of all transactions; stock and

houses are revalued each year, and labour and rent are taken into consideration. A balance sheet for the three years is shown below.

COMPOSITE PROFIT AND LOSS STATEMENT.

YEARS 1922-23-24.

	1922.	1923.	1924.
Valuation Live Stock . .	£9 4 0	£29 9 6	£45 2 6
Do. Equipment .	15 2 0	8 16 0	11 10 6
Expenditure—			
Food	17 8 10	23 9 11	38 19 10
Other Items. . .	1 18 6	4 13 6½	10 2 3½
Labour and Rent . .	4 0 0	17 0 0	18 0 0
Value of Settings . .	...	1 0 4	1 15 9½
Balance, being *profit* . .	26 19 0	29 12 0½	33 4 4½
	£74 12 4	£114 1 4	£158 15 3½
Receipts—			
Eggs—Commercial .	£20 0 6	£39 1 9½	£77 18 4
Setting . .	...	...	7 3 5
Other Sales . .	11 6 0	11 10 9	15 18 8½
Settings retained .	1 0 4	1 15 9½	4 5 4
Manure (Estim.) .	4 0 0	5 0 0	6 0 0
Valuation Live Stock .	29 9 6	45 2 6	33 0 0
Equipment . . .	8 16 0	11 10 6	14 9 6
	£74 12 4	£114 1 4	£158 15 3½

April, 1925.

Autumn-Sown Cereals.

Notes from Craibstone.

WITH the exception of wheat, which, however, occupies but a very limited area, the cereals grown throughout the North of Scotland are invariably sown in the spring-time. The reason for this is that, owing to the lateness of the harvest, labour cannot be spared sufficiently early for the ploughing of the lea for autumn sowing, and in the case of turnips for obvious reasons the cereal following must be spring-sown. Only a very limited area is under potatoes, and still more so under early potatoes, and as these are not as a rule lifted until comparatively late in the season, cereals are not as a rule sown in autumn after this crop.

There would, however, be certain obvious advantages if part of the area under cereals could be sown out in autumn. This would mean a better distribution of the labour throughout the year, and would be of particular advantage in unfavourable seasons where under present conditions spring work has to be carried out in rather a rough-and-ready way. As the autumn-sown crops are slightly earlier than the spring-sown, the harvest work would also be better distributed.

With a view to finding if autumn sowing would in actual practice have any advantage over spring sowing, trials with all the cereals—oats, barley, wheat and rye—have been carried out at Craibstone during the past few years, and the following notes give the general results during this period.

The first trials with autumn-sown oats were carried out in

1919. The seed was sown that year in the beginning of September under very favourable soil and weather conditions. The braird came away quickly and gave every promise of being a satisfactory crop. The crop came through the winter well, but, even although manured in the springtime, it did not respond in any way equal to the spring-sown crops sown alongside. The plants never grew more than 12-15 in. high, and they had exceptionally poor ears, the yield in no case being more than 2-3 quarters per acre.

In the following seasons the same trials were carried out in the same way and with the same results.

The varieties used throughout these trials were Grey Winter, Potato and Victory. Grey Winter stood the winter better than Victory and Potato, but the latter two stocked well in spring, so that at harvest-time there was little in favour of any of the varieties.

In 1923, Potato and Victory oats were sown in the beginning of November, and, curiously enough, these did better as regards both yield and quality of grain than the early sown in previous years. The crops were thinned out somewhat during the winter months, but again they stocked well in the springtime, and in both cases gave an exceptionally heavy yield of straw.

These experiments are being continued, the seeds being sown at different times.

Barley.—The varieties used in these trials were Common, Zero, Squarehead and American Winter, all being sown like the oats in the beginning of September. On the whole, the barley did better than the oats, but it was nevertheless far behind the spring-sown.

Under the conditions of the trials, the plots were comparatively small, and a considerable proportion of the grain was destroyed by birds on account of the crop being slightly earlier than the spring-sown cereals near by.

It was thought at the outset that the oats and barley might be useful for cutting green in springtime, but both proved very disappointing in this respect.

Wheat and Rye.—The trials with wheat and rye have been carried out on a rather more extensive scale than with oats and barley; seed was sown at different times during the autumn and spring months, some being sown on the 1st of each month from September onwards.

The following Table gives the results obtained last year, and illustrates generally the yields got during the period that the autumn-sown crops have been under trial. In both cases it is quite evident that these cereals must be sown comparatively early in the autumn, not later than, say, the middle of October.

RYE.

When sown.	*Grain.* Cwts.	*Straw.* Cwts.
1st September 1922	16·0	53·7
1st October „	15·0	49·7
1st November „	11·6	32·3
1st March 1923	10·0	34·3
1st April „	6·6	28·6

WHEAT.

When sown.	Grain. Cwts.	Straw. Cwts.
1st September 1922	20·3	48·9
1st October „	18·2	40·3
1st November „	12·8	23·1
1st December „	10·5	18·6
1st January 1923	9·7	16·9
1st February „	4·4	13·4

Apart altogether from the effect of early autumn sowing on the yield, several other points of interest and value emerged from these trials. One advantage that was particularly noticed in connection with the early sowing was that not only did the braird come much quicker than in the later sowings, but that a much larger proportion of the seeds germinated, and that, therefore, a relatively lighter sowing would be necessary. In one season wheat was sown on 1st August, but the result was not satisfactory, as the crop was almost entirely choked out by the growth of surface annual weeds, especially chickweed.

The grains, also, from the autumn-sown crops have all along been very much larger and plumper than from the spring-sown.

In the case of rye, ergot has been found very prevalent in the spring-sown but entirely absent from the autumn-sown crops.

In all cases and in all seasons a much longer interval was observed between the time of coming into ear and the date of ripening in the case of the autumn-sown as compared with the spring-sown crops, a fact which is no doubt responsible for the heavier yield of both grain and straw and the larger and plumper grains in the case of the autumn-sown. The same, of course, applies to all spring-sown crops, with which, so far as yield is concerned, the results of trials here have always been very distinctly in favour of the early sown with their longer period of growth.

Farm Pests in Aberdeenshire.

THE following note on the campaign against farm pests in Aberdeenshire is contributed by Dr. James Ritchie:—The efficacy of combination over a wide area for the destruction of the worst of farm pests, a policy constantly advocated in the articles on Farm Pests appearing in these pages, is well shown in the latest annual report of a committee jointly appointed by the County Council of Aberdeenshire and the North of Scotland College of Agriculture. Of the larger mammalian pests in Aberdeenshire, a premium of 7s. 6d. an adult and 5s. a cub induced the death of 150 foxes and cubs, almost all in the wilder parts of the upper Dee and Don valleys; 381 brown hares; and 332 squirrels were killed. Of birds, the slaughter of rooks accounted for 39,891 individuals, and 3978 eggs were destroyed; wood-pigeons, 2366; sparrows 1904, and 647 eggs; starlings, 512; gulls 250, and 1800 eggs. So great a slaughter of rooks—and the vast total does not include many shot by private individuals—must soon begin to tell, and farmers would do well to keep a close watch upon the results, lest over-enthusiasm

in destruction may give a new lease of life and of multiplication to the ground pests, especially leather-jackets or "grub" and wire-worm, upon which the rook levies a heavy toll. The kinds of gulls destroyed are not specified, but there are degrees of criminality in the gull world, and it would be an agricultural blunder were the black-headed gull, an excellent grub destroyer, to suffer for misdeeds due mainly to its larger cousins, the greater and lesser black-backed gulls, and perhaps the common gull.

Poultry Post-mortem Examinations.

In view of the increasing demand from poultry keepers throughout Scotland for post-mortem examinations of fowls, the Royal (Dick) Veterinary College, Summerhall, Edinburgh, have arranged for an extension of the facilities which have hitherto existed at the College for carrying out such work.

Poultry keepers are invited to take advantage of the facilities offered. Carcases of birds for examination should be sent to the Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh. In accordance with the postal regulations specimens must be sent by *Letter Post*, wrapped in a waterproof material and enclosed in a receptacle that will not permit of leakage. The packet so made up must be conspicuously marked "Fragile, with care, Pathological Specimen," and must have the name and address of the sender clearly set forth thereon. The letter of advice must be sent separately. Heavier specimens, similarly wrapped, boxed and labelled, may be sent *by rail*. An advisory letter must be sent by post.

The fee payable for each ordinary post-mortem examination will be 2s. 6d., and a remittance for the amount due should be sent along with the carcases. Where a bacteriological or other detailed examination is considered desirable by the College the sender will be informed accordingly, and if he intimates to the College that he wishes this further examination carried out an additional fee, the amount of which will be intimated to the sender along with the first report, will be charged. Postal Orders, etc. should be made payable to the "Royal (Dick) Veterinary College" and crossed "& Co."

For further information as to the facilities available application should be made to the Secretary of the College.

Scottish Egg-Laying Tests.

IN the JOURNAL for April 1924 reference was made to the Egg-Laying Tests for which the Board were then in process of making arrangements. The first of the Tests, which are being conducted at Seafield, Roslin, Midlothian, began on 15th October 1924 and will continue till 15th September next. There are 67 pens of pullets and 18 pens of ducks of 6 birds each in the competition, and these are divided into six sections as follows:— White Leghorns, 34 pens; White Wyandottes, 9 pens; Rhode Island

Reds, 13 pens; non-sitters other than White Leghorns, 7 pens; sitters other than White Wyandottes and Rhode Island Reds, 4 pens; and ducks, 18 pens. Included among the awards offered in the competition is a challenge cup presented by the Scientific Poultry Breeders' Association for the pen making the best score during the first 84 days of the Test. This cup has been won by Mr. James Prentice, Loancroft Poultry Farm, Uddingston, with a pen of White Leghorn Pullets, which laid during that period a total of 350 eggs; the score value was 348, only two eggs being underweight. The satisfactory results so far obtained in this Test indicate that it may prove an important clue to the development of the poultry industry in Scotland.

Arrangements are at present being made for the second year's Test, which will begin on 15th October next. The closing date for receiving entries is 31st July. Application forms and full particulars of the Test may be obtained from the Secretary of the Board.

Agricultural Conditions.

THE weather during March was especially cold and unsettled in the northern and north-eastern counties. Snow and heavy rains occurred in other districts, but not so frequently as seriously to interfere with spring cultivation; in the western and south-western counties outdoor work went on without a check throughout the month. During April the conditions generally were unfavourable for agriculture and in some districts seeding was fully a fortnight later than in normal years. In several northern counties, however, the weather although cold was fairly dry, and satisfactory progress was made with the sowing of cereal crops. Unsettled weather and low temperatures continued into May, and as a result the growth of young crops was considerably checked, while seasonal work fell in arrear over wide areas. In the south-eastern districts heavy rain rendered land prepared for potatoes unfit for planting. The most satisfactory reports were those from Orkney, Shetland and the western islands, where on the whole the month was fairly favourable for seasonal operations and for the progress of stock.

At the end of May wheat was the most promising of the cereal crops. The plant was reported to be healthy, vigorous and thick on the ground, except on heavy land, where it was rather thin and patchy. In a few cases in North-East Fife it was deemed advisable to have the crop ploughed out during April, while in South-West Fife and East Perth some fields were affected with grub and wireworm; otherwise, however, the reports contained no evidence of damage by pests. The estimates of the acreage sown indicate considerable decreases in South-East Perth, South-West Perth and Berwick, and to a smaller degree in Kincardine, Fife and North Ayr, while small increases are reported from Stirling and North-West Lanark. Taking the country as a whole, the area under wheat will probably show a slight diminution as compared with last year.

The sowing of barley was delayed by wet weather, and only in a few districts had it been completed at the end of April. Some

seeding had still to be done in South-West Perth at the end of May, while in Orkney the sowing of bere had not then begun. Although sown late the crop generally is looking well, the braird being healthy and regular. Growth was, however, rather backward during May owing to the low temperature and the excessive rainfall. In Central Aberdeen and Roxburgh some fields have had to be resown owing to the ravages of grub. From several districts small decreases in acreage are reported, but in most cases it is anticipated that the area under the crop will be equal to that of last year, and accordingly the total area sown will probably prove to be not much below that in 1924.

The reports on oats are not so satisfactory as those on wheat and barley. Sowing was retarded to a considerable extent by the difficulty of securing a good seed-bed, and grub has been unusually prevalent, especially amongst oats after lea; in the north-eastern, eastern and central counties the damage caused by this pest has necessitated resowing on a fairly large scale. Complaints of damage by grub have also been received from the western and south-western counties. From North-East Aberdeen and Wigtown it is reported that a dressing of Paris Green applied to affected fields met with a large measure of success. On clean land and after turnips the braird is healthy and vigorous. According to the estimates furnished by the Board's Crop Reporters, it would appear that the total acreage under oats will, like that of the other cereals, show a slight decrease.

Beans are everywhere reported to be doing well; in Berwick the acreage sown is smaller than usual owing to the unfavourable conditions at seeding time. Ryegrass and clover seeds have made good progress, and with favourable weather it is anticipated that the yield of hay will be above the average in most districts. Where last year's cereal crops were badly lodged, however, clover is somewhat deficient.

The planting of the early varieties of potatoes was well forward at the end of March, and it is expected that with genial weather during June the crop will be ready for lifting at the end of that month. The planting of maincrops, however, was much later than usual owing to the unfavourable weather during April. In several of the more important potato-growing districts, late varieties were not put into the ground until the beginning of May, and work was not completed at the beginning of June; in North-East Fife many fields intended for potatoes were eventually sown with oats. The area sown is estimated to be greater than last year in Moray, North-West Aberdeen, Berwick and Dumfries, but decreases are expected in Banff, Kincardine, Fife, Clackmannan, Kinross, Lanark and North Ayr; elsewhere the acreage is not expected to show any appreciable change. Taking the country as a whole, the area under potatoes will probably be about the same as in 1924. The sowing of swedes was mostly completed by the beginning of June, but in all districts growth has been unusually slow. Little progress had been made with the sowing of yellows at the end of May, while the sowing of mangolds had been to some extent retarded.

The fruit reports are, on the whole, satisfactory. In most districts there has been a good show of blossom; and with genial

weather the prospects are very promising; no reports of damage by either frost or insect pests have so far been received.

At the end of May pasture was fairly plentiful and grazing cattle, generally, made a good start when turned out to grass; in several of the south-western counties, however, cattle have made barely average progress owing to the soft condition of the grass and the lack of sunshine. Dairy cows have done fairly well and the milk yield has increased in most districts. In Orkney, Shetland, Caithness, North Argyll, Dumbarton, Stirling and South Ayr, however, the yield has been below the normal for the period of the year, while in North Ayr the supply had not increased except where cows received full rations and were housed at night. Sheep are generally reported to have thriven well. The crop of lambs both on arable and on hill farms has been a good average, but twin lambs appear to have been fewer than usual. The ewes milked well and lambs are strong and healthy, and are making satisfactory progress. The death-rate has been above the normal in some cases, while in Roxburgh and Wigtown dysentery was unusually prevalent amongst both ewes and lambs. In several districts the number of eild ewes was considerably higher than usual.

The supply of regular labour is generally adequate for requirements. In Aberdeenshire and some neighbouring counties skilled workers have been somewhat scarce, while more dairy workers are required in Dumbarton and Renfrew. Casual labour is fairly plentiful, except in Berwick, where women workers are short of requirements.

RECENT PERIODICAL LITERATURE.

A number of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins and to the original publications quoted therein may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

Artificial Drying of Crops by Hot Air. *The Field, Vol. CXLIV., No.* 3748. *London*, 1924.—A process has been developed by the Institute of Agricultural Engineering at Oxford which should enable farmers to secure undamaged hay and corn crops in spite of unfavourable weather. The crop is harvested as usual and, when possible, exposed for some hours previous to stacking. A circular stack is built round a central conical chamber, consisting of wire netting on a wooden frame. Hot air is then blown into the centre by means of a sheet metal duct from a heater in which atmospheric air has been made to circulate round red hot pipes. The hot air permeates the whole stack, the moisture is driven off as steam, and after 9 hours a stack of about 25 tons is thoroughly dry.

Feeding trials will be made during the coming winter to compare the relative value of air dried and ordinary dried products; it is estimated that the loss in nutritive value by the hot air method should be negligible.

The following comparative figures based on this year's trial demonstrate the economic advantages of the hot air process. When taken up on a commercial scale, it is estimated that the initial outlay on apparatus should not be more than £50, exclusive of the tractor and other power unit.

Haymaking per ton of green material.

	Cutting.	Carting and Stacking.	Artificial Drying.	Haymaking.	Total Cost.
I. Good Season—	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Artificial method .	3 0	7 0	1 6	...	11 6
Ordinary method .	3 0	6 0	...	4 6	13 6
II. Bad Season—					
Artificial method .	3 0	7 0	1 6	...	11 6
Ordinary method .	3 0	6 0	...	9 0	18 0

On Peat. *Spirhanzl, Ing. J. O. Ueber Torf. Prague, Czecoslovakia*, 1924.—In this book the author describes the general properties of peat, such as water capacity, hygroscopicity, power of absorption of gases, its true and apparent specific gravity, cohesion, elasticity, capillary attraction, heat conductivity, effect of heat, and its acidity.

The formation of peat-moors is then dealt with, and their geographical distribution and extent in Czecoslovakia are discussed and shown on a map.

In the last chapters the author treats of the cultivation of peat-moors, drainage, fertilisation, etc., and the means by which they may be rendered serviceable to agriculture, gardens, and in various industries of the Czecoslovakian Republic.

The appendix to the book contains a full index of the literature on this subject.

Sources of Ammonia in Potato Fertilizers. *Lipman, Dr. J. G., Bulletin* 39. *The State Potato Association, Trenton, State of New Jersey, U.S.A.*, 1924.—The sources of fertiliser ammonia are classified under three heads, namely, ammonia from nitrates, ammonium salts and from organic sources. Ammonia compounds come largely from two sources: sulphate of ammonia and so-called base goods, the latter being produced when lower grade animal products are treated with acid in making acid phosphate. A large proportion of the ammonia in mixed fertiliser is derived from base goods.

In addition to true organic sources, such as tankage, fish and cotton seed meal, ammonia is also derived from cyanamide, and in the future "urea" will doubtless play an increasing part.

In mixtures, more than one source is employed, as by so doing a more continuous supply of ammonia is given to the plant and the fertiliser is safer in use, especially from the standpoint of acidity, as the source has a great deal to do with soil acidity.

The degree of soil acidity is important in the prevention of scab, and other things being equal, only such fertilisers should be used as will reduce the danger from scab.

As regards cost, it is obvious that organic ammoniates are expensive and should be cut down, unless they are more efficient than other sources, and at best the efficiency of animal products is no greater than that of chemical carriers of ammonia.

Nitrate of soda will tend to make the soil less acid, whereas sulphate of ammonia increases acidity, and where scab is prevalent the latter is the better source of ammonia. Bone meal tankage, fish, basic slag and cotton seed meal will also have a tendency to make soil less acid, whereas chloride or sulphate of potash, acid phosphate, sulphate of ammonia and other ammonia salts will have the opposite reaction. Where the grower is confronted with a bad scab problem and drastic treatment is necessary, sulphur is the best remedy.

When the condition of the soil is such that scab is no longer troublesome, it is better to use a combination of fertilisers, in order to maintain the soil at the same degree of acidity. There is danger in the continued use of fertilisers such as would ultimately make the soil too acid to obtain a good crop. It is important to avoid dependence on acid fertilisers which in time would lead to undue accumulation of acidity in the soil, beyond the point where our particular problem is met.

The Value of Sulphur in Soil Improvement and Crop Production. *Lipman, J. G., Industrial and Engineering Chemistry, Vol. XVI., No.* 3. *Washington, D.C.*, 1924.—The author first points out that sulphur and the compounds containing it are daily applied on a vast scale in all fields, and especially in that of agriculture. Besides furnishing the supplementary portion of the element of sulphur, necessary for plant nutrition, when it is not found in sufficient quantities in the soil in an assimilable form, it imparts such acidity to the soil as to prevent the growth of certain fungi, and especially of certain organisms which cause serious plant diseases, such, for instance, as potato scab. Sulphur may also be used to correct the undesirable conditions of an alkali soil, to suppress and eliminate insects infesting the soil and to eradicate weeds.

In this note the author gives some data representing the result of numerous tests made by him, over a period of several years, in collaboration with other investigators, with the object of examining and controlling potato scab. These data show that the efficacy of flowers of sulphur sold on the market is in direct ratio with its decree of fineness. Indeed, among the various qualities used in the test, the finest (passed through a 200-mesh sieve) was in every case the most effective.

The results of certain tests are then given, in which, still with a view to the treatment for potato scab, sulphur was administered together with the usual fertilising nitrates, that is, ammonium sulphate and nitrate of soda.

The best results were obtained with ammonium sulphate. The sulphur mixed with an equal quantity of ground natural phosphate gave excellent results, superior to those obtained with sulphur alone. But besides these concrete results, the tests made by the author and his collaborators have shown the tendency, more or less evident but always observable, to an increased yield in the crops when sulphur was used against scab. It seems then that, under determined conditions and in conjunction with other factors, sulphur has a stimulating effect on the growth of potatoes, tomatoes and perhaps also on other crops.

Field Crop Response to the Ingredients of Potassium Salts. *Hartwell, B. L., Damon, S. C., Crandall, F. K., Journal of the American Society of Agronomy, Vol. XVI., No.* 10. *Geneva, N.Y.*, 1924.—Under certain conditions carriers of potassium, as well as of the other two fertiliser elements, may have marked crop effects other than those caused by the fertiliser elements themselves serving directly as nutrients.

In the authors' experiments, magnesium potassium sulphate, potassium chloride, potassium sulphate and kainit were used under such conditions that not only the potassium, but also the other ingredients, should have an opportunity to exert on the crop any effect of which they might be capable.

For ten years the basal fertiliser common to all the experiment plots was composed of materials not containing potassium, sodium, magnesium, sulphur or chlorine. These elements were added in one or more of the commercial potassium salts, and comparisons made with the no-potassium plot. On the control plot there was no apparent deficiency of potassium until 1918.

During the last five years, if the average percentage increase due to the magnesium-potassium sulphate is taken as 100, sulphate of potash equals 109, chloride of potash 113 and kainit equals 135.

Sodium is useful when potassium is insufficient, and the superiority of the kainit was no doubt due to its containing about twice as much soda as potash.

If sulphur had any effect, it was apparently less than that exerted by the sodium ; magnesium was evidently not deficient.

Utilisation of Nitrogen in Soils and Fertilisers as Affected by Lime. *Lipman, J. G., and Blair, A. W., Industrial and Engineering Chemistry, Vol. XVI., No.* 4. *Washington, D.C.*, 1924.—This report contains the results of a series of investigations commenced as far back as 1898, which consist of tests made in small cylinders exposed to the air, and therefore under normal conditions, with the object of examining some phases of nitrate fertilisation. The following were used as fertilisers : nitrate of soda, ammonium sulphate, dried blood and stable manure and mixtures of nitrate and stable manure, ammonium sulphate and stable manure, dried blood and stable manure. In a first period of 10 years, the tests, which were all made in triplicate, were carried on by giving to all alike, lime in the same proportions. At the beginning of

the second period of 10 years, the various cylinders containing the samples were divided into three groups, *a*, *b*, and *c*. To the cylinders in the first group the various nitrate fertilisers were added and no lime; to the second group were added the usual nitrate fertilisers and lime at intervals of 5 years; those in the third group received, in addition to the nitrate fertilisers and lime (applied in the same way as for group *b*), nitrogen by means of a legume crops, twice in a period of 5 years.

The chief problems examined, in these numerous series of tests, were the following:—(1) Available nitrogen in the various nitrogenous products in use, either alone or mixed with stable manure; (2) ascertaining whether denitrification takes place when they are used in combination with nitrate of soda and stable manure in the usual annual proportions; (3) determination of the influence of the various nitrate treatments on the proportion of nitrogen in the crop; (4) ascertaining the extent of the loss or gain in nitrogen by the soil contained in the cylinders after the various treatments.

In this note the authors, however, only give a part of the data collected in these numerous tests. From these data it may be concluded that the continued use of ammonium sulphate, without lime, causes a strong acidity of the soil, so strong as practically to prevent plant growth. In the group *b* tests, on the other hand, results show that by the application of ammonium sulphate, with lime, the crops are normal. Stable manure tends to correct the injury caused by the continuous use of ammonium sulphate without lime. It was then found that, in a normal soil, denitrification does not take place when nitrate of soda is used with the right proportion of stable manure. By the use of nitrate of soda mixed with stable manure production is maintained at a high level, the increase obtained with this mixed fertiliser being often greater than the sum of the increases obtained with the two fertilisers used separately.

The same was also true in the case of mixtures of stable manure and ammonium sulphate, stable manure and dried blood, and finally, in a lesser degree, in the group of cylinders to which lime was not administered. The increase of nitrogen in the various crops by using the mixed fertiliser (stable manure and one of the nitrogenous products on the market) was generally equal to, or greater than, the sum of the amount recovered by using the same fertilisers separately. The percentage of nitrogen found in the dry material is, in many cases, influenced by the nitrogenous material used, and also by the presence or absence of lime, also by the fact that legume crops have or have not been introduced in the rotation of the crops.

The total quantity of nitrogen in the crop then depends entirely on the treatment with lime and on the green leguminous crop in the presence of lime.

Size of Potato Sets: Comparisons of Whole and Cut Seed. *Stuart, W., Lombard, P. M., Vosbury, M. C., Corder, G., Edmundson, W. C., Clark, C. F., and Dewey, G. W., United States Department of Agriculture, Bulletin No.* 1248, *bibliography. Washington, D.C.*, 1924.—Although reports from various quarters are somewhat conflicting as regards the yield of potatoes from whole and cut tubers, the data obtained as a result of experimentation in the States permit certain practical conclusions. Where there is a deficiency of moisture and plant food, medium sized cut sets are advised, as the relative number of tubers produced will have a chance to reach a marketable size. A study of stem frequency correlation shows that, as the weight of the whole seed increases from 2 to 6 ounces, the stem frequency varies from 3 to 7 stems respectively. Halved sets show a variation from 2 to 4 stems, and quartered sets from 3 to 6 ounce tubers average 2 stems.

The authors review the causes for disagreement as to the practicability of planting whole or cut sets and draw attention to the varying climatic and soil conditions, and more especially to the spacing of the sets to allow the maximum development. A comparison is made of the experiments carried out by numerous investigators and a detailed description is given of the tests made in recent years in the States.

Seed Potato Improvement Methods in the United States. I.—*Perry, P. R., The State Potato Association and the State Alfalfa Association, Bulletin No.* 39. *Trenton, New Jersey*, 1924. II.—*Bemis, K., Idem. Trenton, N.J.*, 1924.—I. The author reviews the following methods employed in New York State in order to obtain clean seed potatoes, viz., "the index method" for the

elimination of mosaic and leaf roll, which is essentially a green-house method, and the "hill selection" for field work. The practicability of seed treatment is then discussed. Several growers tried the hot formaldehyde method with some success, but with variable results as compared with corrosive sublimate.

For use on a large scale, a machine has been constructed, using the Boggs type grader chain of small mesh. The potatoes are driven through the disinfectant solution which is contained in a vat and kept at a temperature of 126° F. After two minutes they are passed to the drying box placed directly underneath the vat, and from thence into the chute for bagging. The use of hot corrosive sublimate in place of the formaldehyde has resulted in a distinct saving of time. Tests made to ascertain the limit of resistance of the potato as regards germination capacity, indicate that a 2-minute to 10-minute period is a safe margin, taking the 4 oz. to 30 gallons strength of the solution. The temperature of 126° F. was found to control 98 per cent. of the sclerotia.

Arrangements have been made in the various districts for the use of a community vat.

To overcome the deleterious action on metallic substances such as iron, experiments have been made which demonstrate the value of a gas tar asphalt compound painted on iron surfaces. A simple chemical test is described by which the strength of the disinfectant can be readily ascertained; a pinkish orange precipitate is obtained by pouring the corrosive sublimate into a potassium iodide solution.

II. Certification work in Michigan is in the hands of the Agricultural College and is based on the selected strains of seed potato produced by the Plant Pathology Department. The grower when applying for certification is obliged to specify—that no potato crop has been grown on the land for the past 4 or 5 years; also the strain of seed and provenance. Treatment with corrosive sublimate is required.

If the percentage of disease exceeds 5 per cent. the field is condemned, and a second inspection is unnecessary. Otherwise this is considered important, and also a bin inspection for wilt, black scurf and scab, and an additional inspection at loading time in case of frost injury or browning.

The author describes the organisation of the Michigan Potato Growers Exchange, the selling agent for seed growers.

Potato Sprouts as an Index of Seed Value. *Appleman, C. O., University of Maryland, Agricultural Experiment Station, Bulletin* 265. *College Park, Md.*, 1924.—The data obtained from these experiments give a simple and practical means of detecting and eliminating weak tubers in potato seed stock. The sprouting tests here described demonstrate the significance of apical dominance and its relation to the seed value of tubers. The conditions under which this method may be employed as a practical index of vitality in seed tubers are discussed.

Experiments have shown that, when sprouts are removed from potatoes in storage and another crop allowed to grow, the total number of sprouts produced by Lot 1 up to planting time was nearly double that produced by Lot 2. It is considered inadvisable to remove the sprouts before planting if they are short and vigorous.

These investigations seem to form a basis for the final test and judging of seed potato selection and certification.

Soil Tilth in Relation to Mechanical Tillage. *Keen, B. A. Farm Implements and Machinery.*—Valuable work has been carried out on the heavy soil of Rothamsted with the help of a dynamometer, which records the drawbar pull and speed of travel of the tractor, and, when ploughing, the depth of furrow. The experience of the Rothamsted Station is that the tractor decreases the cost of work and gets it done in a given time; further, that high running expenses so often complained of, result from insufficient attention to the machinery. It was found that the resistance offered by the soil affects the speed of the tractor rather than the drawbar pull. The result follows that the power consumption per acre depends mainly on speed, or the fuel consumption per hour is about the same whether the tractor takes 2 or 4 hours to plough an acre. Hence, time, fuel and wages are saved if the tractor is driven at as high a speed as is consistent with its construction.

As regards deep ploughing, it was found that the power consumption rose 100 per cent. for a 6 inch depth of subsoiling in heavy clay.

Power consumption was found to be reduced as much as 15 per cent. by chalking the land.

A reduction of friction on the mouldboard was obtained by electrical agency. If a current of electricity is passed through the moist soil from the coulter to the ploughbody, a film of water is deposited over the latter and acts as a lubricant. The laboratory results were confirmed in the field by the use of a tractor on which a dynamo was fitted.

Allusion is made by Dr. Keen to the relative value of broken and unbroken furrows in reducing the work of subsequent operations, and the possibility of rotary tillage to produce a seed bed in a single operation.

Slaughter-House Blood in Animal Feeding. *C. V., Revue de Zootechnie, La Revue des éleveurs, Vol.* 3, *No.* 9. *Paris,* 1924.—Blood, because of its constituents, is representative of the animal organism, and because of its wealth in nitrogenous matter can, as a food, be of great service in cases of intensive production. On the other hand, it is liable to promote disease, putrefies rapidly, and is very difficult to preserve.

Dr. Gauducheau makes the following suggestion for the treatment of blood: Vinegar and sugar should be added at the time of collection at the slaughter-houses, also an alcoholic yeast (Saccharomyces) should be mixed with it, and the blood should then be kept at the most suitable temperature for preservation.

Active fermentation starts at once, producing a substance of distinctive and pleasant taste, and having satisfactory preservative qualities. As there is no heating, the contained protein, diastase, and vitamins remain intact.

Blood treated in this manner is a satisfactory product and very nutritious. Young rats fed on it in the proportion of 1 to 20 in their daily ration developed two or three times more rapidly than others not so fed, their increase in weight was 20 to 30 gm. per head and per day, whereas that of the others was only 10 gm.

It should be noted that the stimulating action on growth does not continue after the first week, but the progress achieved is maintained; this is easily explained by the fact that, when blood has supplied a sufficient quantity of amino-acids, iron and vitamins, that were lacking, or were present in insufficient quantities in the ordinary ration, its use ceases.

Sex of Long-Carried Calves. *Hooper, J. J. The Breeders' Gazette, Vol. LXXXVI., No.* 13. *Chicago, Ill., September* 25, 1924.—It is a widespread belief among farmers that male sex is predominant among long-carried calves.

In order to reach a definite opinion on this point the author has studied the records of the Kentucky station herd with respect to about 500 pregnancy periods noted during the last 30 years; 44 cases out of this number exceed the normal period of pregnancy (283 days) by 7 to 17 days, and of the 44 long-carried calves born, 25, *i.e.* 59 per cent., were males, and 19, *i.e.* 41 per cent., females. This would, therefore, be a ratio of 4 females to 6 males.

The Influence of Pasteurization and Diet of the Cow on the Anti-Scorbutic Potency of Milk. *Olson, M. T., and Capeland, L., Journal of Dairy Science. Vol. VII., No.* 4. *Baltimore,* 1924.—Experimental work undertaken to ascertain the antiscorbutic value of various quantities of milk produced and treated as follows:—

(*a*) Milk of cows fed a winter ration of ensiled maize.

(*b*) Milk of cows fed a winter ration without ensiled maize.

(*c*) Milk pasteurized in bottles, by heating to 52·8°C. for 30 minutes, compared with fresh, raw milk, from the South Dakota State College herd.

Twenty-four guinea pigs were used in experiment; the animals were quite young at the start of the experiment and weighed about 300 gm., and had been put on full diet before the experiment. Groups were formed consisting of equal numbers of males and females, uniform in all respects.

The maintenance ration consisted of crushed oats and good lucern forage, finely cut and steamed in a self-regulating apparatus for 30 minutes at a pressure of 15 lbs. per sq. in. and then dried; water and salt were added.

In 5 graphs the authors show the results obtained and state the following conclusions :—

(1) The basal ration totally lacks "C" vitamins.

(2) Pasteurization in closed bottles at 61°C. for 30 minutes decreases the percentage of "C" vitamins in milk.

(3) "C" vitamin in milk owes its origin to food.

(4) Ensilage of cut maize when the grain is glazed, but before desiccation of the lower leaves, considerably increases the anti-scorbutic potency of milk.

(5) A good quantity of ensiled maize contains enough "C" vitamins to allow for a sufficient quantity in the milk.

Variation of Cream Tests. *Challis, E. C., Journal of the Department of Agriculture, Union of South Africa, Vol. IX., No.* 4. *Pretoria*, 1914.—The causes of variations met with in cream tests are discussed, and attention drawn to what is probably the chief cause of such variation, viz, the running of the cream separator at different speeds.

A separator was run at the correct speed of 60 revolutions of the handle of the machine per minute and cream containing 34 per cent. butter-fat was produced ; the speed was then increased to 74 r.p.m. when the fat percentage rose to 52 per cent. In another case by reducing the speed of the machine 25 per cent. the fat content of the cream fell from 54 to 26 per cent.

Production of Cow's Milk with Antirachitic Properties. *Lesne and Vagliano. Comptes Rendus habdomadaires des seances de l'Académie de Science, Vol.* 179, *No.* 11. *Paris*, 1924.—It is known that the milk of certain animals lacks antirachitic properties and the authors have made experiments with a view to remedy this by modification of the cow's food.

An extract of 500 gm. of cod-liver oil was added to the daily ration of a healthy dairy cow ; the food was well assimilated ; the general health of the cow remained excellent, appetite increased and there was no digestive trouble of any kind ; the milk produced did not diminish in quantity nor show any difference in smell, colour or taste. The butter was of lighter colour, but was satisfactory in taste ; there was no difference in the quantity of butter-fat produced, which varied from 38 to 42 gm. per litre. Calcium content per litre = 1·23 gm.

Phosphoric acid (P_2O_5) = 1·40 gm. instead of the normal 0·4 to 0·6 gm.

The butter produced is rich in growth-vitamins (factor "A"). Young rats fed on husked rice, refined casein, yeast, and 3 per cent. of butter from milk taken from a normally fed cow increased in weight by 15 gm. in one month ; whilst those fed in the same manner, but with 3 per cent. of butter from the milk of a dieted cow, increased in weight by 35 gm. in one month.

Butter made from the milk of a cow fed on cod-liver oil contained, moreover, antirachitic properties, for young rats of 30 gm. weight subjected to a rachitogenous diet but with butter from the milk of a dieted cow, only showed on inspection 25 days later very slight rachitic lesions, while the majority of them displayed no traces of disease.

On the other hand, rats thus experimented upon whose diet included butter from milk of a normally fed cow suffered from rickets to a marked degree.

Butter from milk of dieted cows possesses curative qualities in addition :— young rats of 30 gm. weight were subjected to the rachitogenous diet for a period of 15 days, after which butter from the milk of dieted cows was substituted in their ration for ordinary butter ; they mostly regained their normal health on the 40th day, a few only still showed slight rachitic lesions.

The organism however does not retain the antirachitic factor ; cod-liver oil absorbed by female animals during pregnancy, or during lactation, does not assure immunity for the young when later these are submitted to a rachitogenous diet.

In conclusion, it can be said that milk from dieted cows whose rations include a considerable quantity of cod-liver oil produces a quality of butter richly supplied with glycerophosphates (lecithin) and with growth-vitamins. Milk thus produced has both a curative and a preventive action on rachitis, as shown by experiments on rats. Such milk has a certain therapeutic value on infantile rachitis, and its use is recommended for the feeding of children whose unhygienic surroundings predispose to rachitis.

Cross-Breeding of the First Generation in Poultry-Rearing. *Legendre, G., La Revue de Zootechnie (Stock Breeders' Review), Year 3, No. 8. Paris,* 1924.—In poultry farming it is not the laying of eggs alone that provides profit. Numerous factors contribute to it, amongst which should be named, besides abundant egg-laying during the winter season, early development, sexual precocity, size of eggs, vitality of embryos and young birds, adaptability to various external conditions, ability to obtain nourishment from the food supplied, etc.

Mixed breeds, therefore, undoubtedly possess valuable qualities, especially in regard to the last features.

In order to bring about an equal distribution of the qualities pertaining to pure and to mixed breeds, cross-breeding in the first generation has been resorted to, known as "industrial breeding."

In the case of poultry, the results shown by such first cross-breeding are as follows:—

Egg-laying:—(1) The hybrids obtained by crossing two breeds often prove more prolific than their parents, an increase of 10 eggs per head per year can be attained.

(2) Whatever may have been the vitality of the breeds crossed, the hybrids' eggs show better fertilisation and less waste. There is also a decrease in the death rate during rearing.

(3) Precocity is greater; young cocks reach market weight a week earlier than those of pure breeds, which results in greater economy of time, labour and food.

(4) It is understood that owing to their greater vitality and greater fecundity, hybrid hens can be kept to advantage for longer periods; hence a further economy is effected as regards egg-laying and the care of birds reserved for reproductive purposes.

	Pure Breeds.	*Cross-breeding of First Generation.*
Fertility of eggs, . . .	80-85 per cent.	85-90 per cent.
Hatching as per fertile eggs, .	70-75 „	75-85 „
Death-rate during rearing, up to period of egg-laying in relation to birth-rate, ...	25-30 „	15-20 „

(6) In some cases, in special crosses, it is possible to select, with a fair degree of accuracy, the male and female birds at the time of hatching. This allows of immediate treatment according to their different requirements, fattening for the market, or egg-production.

However, the crossing of breeds of the first generation also presents serious disadvantages; this has been proved in actual practice.

(1) The tendency of hens to sit is greatly increased. In order to obtain a regular output of eggs it is important to prevent them from sitting immediately the tendency is shown.

(2) It is necessary to keep two pure-breed pens, of which one should be larger than the other: the one for the cocks should be the smaller, as very stringent selection cannot be so easily followed.

(3) The only remunerative sale is that of selected fowls or sittings of eggs from the two pens of pure-bred fowls.

In practice crossing can be effected by three different methods:

(a) *Cross-breeding of two light breeds*, producing hybrid hens of maximum sexual precocity, that may hatch late in the season, when egg-laying is abundant and temperature favourable to rearing. This method is best suited to specialised production of eggs.

(b) *Cross-breeding of a light breed with a heavy breed.*—In this case the cock is taken from the light breed, so that the hens are not injured. A special feature of this form of breeding is the particularly rapid development of the young cocks, which inherit the mother's strength; the young hens will, on the contrary, inherit from the cock's side. The young birds in this case will be heavier, and will require more feeding than in the first instance, but will possess the maximum of qualities sought for in poultry-farming.

(c) *Cross-breeding of two heavy breeds.*—Minimum advantages to be obtained.

After study of the practical effects of the second method of crossing, the author is of opinion that it is too complicated, entailing considerable expenditure for installation, labour, etc.

In short, in spite of the real advantages to be derived from the crossing of the first generation, it would seem that the actual money return is higher from well-tended pure breeds.

The Eggs of Tuberculous Fowls as a means of Transmitting Avian Tuberculosis. *Fitch, C. P., Lubbehusen, R. E., Dikmans, R. N. Journal of the American Veterinary Medical Association, Vol. XVI., New Series, Vol. 19, No. 1. Detroit*, 1924.—Avian tuberculosis has become very important, not only on account of the development of aviculture, but because of its connection with the tuberculosis of other domestic animals. It is generally admitted that avian tuberculosis is transmitted by the excrement of infected fowls; it has also recently been asserted that the eggs of those affected with tuberculosis constitute a means of dissemination.

After having referred to the investigations and results arrived at up to the present day, the authors give the results of their own investigations.

They utilised 62 fowls, of which only 43 laid, which implies that about 30 per cent. of tuberculous fowls, in all stages of the disease, produce no eggs. 876 eggs were examined; 367 by the Erlenmeyer method of flask culture and 509 by inoculations in guinea pigs. The tuberculosis germ was found in a group of 9 eggs coming from 2 different fowls.

It may therefore be safely concluded that less than 1 per cent. of the eggs laid by tuberculous fowls contain live tuberculous bacteria. The authors have shown that chicks may be hatched by incubating infected eggs and that it is possible for an egg naturally infected to give birth to a tuberculous chick. It is, however, absolutely denied that this can take place in practice and be of a nature to cause an active dissemination of the disease.

The authors have also examined the shells of 209 eggs laid by fowls recognised as tuberculous and sullied by excrement. The shells were carefully washed in a sterile saline solution, which was afterwards centrifuged; the sediment was injected in fowls intraperitoneally; in no case did the injection cause tuberculosis.

The general conclusion may be drawn that the egg plays no important part in the transmission of avian tuberculosis.

Broodiness and Egg Production. *Voitellier, Ch. La Revue Avicole, Year 34, No. 10. Paris*, 1924.—Breeders are generally agreed that broodiness among hens is not favourable to egg-laying.

A broody hen does not lay eggs; while sitting it does not lay, and after sitting it is physiologically unable to lay eggs for a long period. The author refers to the results of several recent experiments on this question. Hens becoming broody four or six times during the year have laid more eggs than those that did not display the same degree of broodiness. In 1920 Goodale established that there could be no positive connection between the amount of time given to incubation and annual egg production.

In an experiment dealing with 152 fowls of heavy breeds (88 white Wyandottes, 16 buff Orpingtons, 16 white Orpingtons, 16 fawn-coloured Rocks, 8 Rhode Island Reds and 8 red Sussex), the results in relation to broodiness are summarised as follows:—

	Eggs.	*Average production.*
Hens showing no broody propensity, .	26	150
„ ready to sit once, ...	10	172
„ „ twice, ...	14	187
„ „ 3 times, ...	14	182
„ „ 4 „	19	174
„ „ 8 „	7	166
„ „ 10 „	8	164

A group of buff Orpingtons (in which a total of 37 instances of broodiness had been noted), gave an average production of 178 eggs per hen; one of these, whose recorded sittings amounted to ten, produced 176 eggs.

It should be noted that in these cases the propensity to broodiness was hindered by the fact that the hens were placed in open coops and that, if

checked, a hen often exhibits the desire at fairly frequent intervals. Moreover, the tendency to broodiness is only shown by birds that have already laid a fair quantity of eggs.

According to the author the direct causes of broodiness are not yet known; the tendency is not permanent, it is displayed at constant and regular intervals in wild birds, after a certain number of eggs have been laid, but is very irregular in domestic birds owing to the modified functioning of the ovary, a result of intensive feeding and other causes.

Although it is difficult to modify the existing relation in a breed between laying and broodiness, and as the initial cause of broodiness is admittedly the laying of eggs, there is a risk that, in trying to do away with the first, the second might be decreased. A competent breeder should be able to attain his aim if it were proved that the persistence of broodiness is really detrimental to great production, considering that races and species of varied tendencies have been produced by natural development.

The Recurrence of Animal Plagues. *C. S. Elton in British Jour. Exper. Biology, October* 1924.—It is stated that records of animal plagues, such as the vole plagues of Scotland, show that there is a more or less regular recurrence of such years of abnormal multiplication, and that the unusual increase is not purely a local event, but may have its counterpart far afield. Thus during the vole plague of 1875 in the Scottish lowlands, other vole plagues occurred in the Athabasca-Mackenzie region of North America, in Norway and in Galicia and Hungary; while the years of the plague of 1891 to 1893 were marked by similar plagues in the Athabasca-Mackenzie region, in Norway and in Thessaly. This suggests the presence of a wide-spread factor influencing all these distant areas in similar manner, and the author falls back upon some great climatic factor. The animal plagues seem to run in two series, one set recurring every 11 years, the other every 3 to 6 years, sometimes with a more marked increase in the 11 year period. In his search for a wide climatic factor having an 11 year period, Mr. Elton has reached a possible solution in the increase and decrease of sunspots, for it is said that here an 11-year periodicity is apparent, and that sunspot periodicity has already been shown to be reflected in climate in various parts of the world, in the growth rings of the 2000 years old red-wood trees of America. It is possible, therefore, that the recurrence of our animal plagues is one of the manifestations of the influence of the fluctuations of the distant sunspots.

The Wheat Bulb Fly. *H. M. Morris, Bull. Entom. Research, April* 1925. —This serious pest, which may entirely destroy a wheat crop, though it more commonly results in a crop that is thin and patchy, causes most damage in the eastern counties of Scotland and England. Prof. Gemmill has already recorded the observations on wheat bulb fly in this JOURNAL (1923, pp. 192-196), and the present paper confirms some of his observations and adds further statistical data. That the eggs are laid on bare loose soil surfaces is as true for Rothamsted as for Dundee; in the former the number of eggs, based on many samples, is estimated at 166,000 per acre, distributed almost wholly in the surface inch of soil. In the laboratory, on damp blotting paper, the eggs hatched between 19th December and 14th January and the larvæ were placed on young wheat plants growing in pots. Several of the plants were destroyed, and larvæ were found on plants upon which none was placed, indicating that the larvæ have certain limited powers of migration.

The Starling in America.—*May Thacher Cooke, U.S. Dept. Agr., Dept. Circular* 336, *March* 1925.—For a score of years unsuccessful attempts were made to establish the European starling in America, but it was not till 1890 that it became firmly established in New York City. From that time till now it has been making the most of its new country, spreading far and wide from the original centre in circles which have been traced north, south and west every year. When these latest observations were made in 1924 it extended from central Maine to central Ohio, and from Georgia and Alabama north to Ottawa and Montreal in Canada. What has been the agricultural effect of this introduction? In Britain starlings seem to be increasingly guilty of damage to crops, but in America they do not yet seem to have reached that stage. The worst that can be said of them there is that they nest abundantly

about dwelling-houses and are dirty birds, that they are pugnacious and tend to drive away native birds, particularly blue birds and flickers, and that by flocking and roosting in great multitudes they occasionally destroy shrubberies. On the other hand, their food habits confer benefit on the gardener and cultivator generally and are, in some cases at least, more useful to man than those of the birds they supplant.

The Importation of the European Brown Hare to America and Its Results. *James Silver in Jour. Agr. Research, Washington, Vol. XXVIII.*, 1924.—The common European brown hare was first liberated in New York State in a game preserve, but it was ultimately set free in the open, as the preserve proved unsuited for coursing, even had the 9-mile fence that was erected been capable of retaining the animals. As the result of this and some four other importations, brown hares have increased and spread slowly but steadily during the last 30 years in the eastern States of America, so that they now occupy an area extending from southern Vermont southward to central New Jersey, eastward 20 or 30 miles into Connecticut and Massachusetts, and westward across the Hudson and Delaware rivers. It is estimated that their numbers vary from 6 per square mile in Duchess County to about 30 near Sheffield, Mass. The only damage which has been laid to their door is the barking of young orchard trees, especially in severe winter weather; but this destruction is sufficiently serious, "many orchardists counted trees destroyed by the hundred, a number which often represented entire orchards." In Duchess County alone, in the winter of 1915-16, the damage was estimated to exceed $100,000, and the institution of a system of bounties resulted in the death of about 10,000 individuals from 1912-15. Apart from shooting, control measures have been tried with considerable success. They include winter feeding, on the theory that it is cheaper to feed the hares than to fight them, repellant washes, such as concentrated commercial lime-sulphur, and 30-inch-high poultry netting of 1-inch mesh encircling the base of the trees.

Increase of Mountain Hares in Southern Scotland. *J. Ritchie in Scottish Naturalist*, 1925.—From an examination of game-book statistics from two different localities in the Scottish Lowlands, Dr. Ritchie concludes that the numbers of mountain or blue hares still show a steady and very considerable increase. The numbers of hares killed each season from 1901 onwards, on a 5500 acre hill farm in Kirkcudbrightshire—The Mair, owned by Col. J. Craig of Ayr—have increased from 37 in 1901 to 230 in 1921, and a grouping of the results of the annual shootings in 5-yearly periods shows a steady advance. Thus in the period 1901 to 1905 169 hares were killed; in 1906 to 1910, 263; 1911 to 1915, 515; 1916 to 1920, 667; and for 1921 alone, 230. At Allershaw in Lanarkshire, on the border of Dumfriesshire, the numbers of mountain hares killed were 304 in 1921, 332 in 1922, 425 in 1923 and 415 in 1924. It was natural to expect a gradual increase of this species in the Lowlands, for they were only introduced in small numbers upon the southern uplands from 1834 to 1868. Apparently the increase is still in progress, and it is likely to be checked only when the numbers approach the limit of the food supply. The matter is of some interest, especially to sheep farmers on the hill pastures of the area, for if pasture is devoured by hares, it is obvious that by so much the amount available for sheep is diminished.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in March, April and May 1925.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	March.			April.			May.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK:—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	67 6	61 5	44 10	68 5	62 8	47 8	68 3	62 3	48 5
Cross-bred (Shorthorn)	63 1	57 2	41 3	63 10	58 8	42 1	63 9	58 2	42 8
Galloway	62 4	56 6	...	63 11	59 1	.	64 6	59 8	...
Ayrshire	60 0	50 0	36 0	62 0	52 0	38 0	60 0	50 0	36 6
Blue Grey	.	. .	...	64 4	...	...	65 0	...	...
Highland	...	...	...	...	...	...	...	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES	18½	11¾	...	18½	12	8	16¾	11¾	8
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb d.	Ewes per lb. d.
Cheviot	19	17½	15	19½	18¼	15¼	19¼	17¾	15
Half-bred	18½	17½	13¼	19	18	13¼	18¾	17¾	13
Blackface	18¼	17¼	13½	19	18	14	18¾	17½	14
Greyface	18½	17¼	11½	19	17¾	11¼	18¾	17½	11
Down Cross	18½	18	...	19¼	18½	...	19	18	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	13 2	11 11	...	13 4	11 11	9 0	12 10	11 6	.
Porkers	13 4	12 5	...	13 7	12 6	9 0	13 3	12 1	...

Average Prices of Live Stock in Scotland—*continued.*

Description.	March. 1st.	March. 2nd.	March. 3rd.	April. 1st.	April. 2nd.	April. 3rd.	May. 1st.	May. 2nd.	May. 3rd.
STORE STOCK:—									
Store Cattle—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head	Per head.	Per head.
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings ..	19 16	16 2	14 6	21 16	17 10	14 1	21 15	17 3	14 1
Two-year-olds	26 1	21 9	18 0	28 14	23 17	19 16	27 18	22 19	19 8
Cross-bred (Shorthorn):									
Yearlings ...	18 10	14 18	13 2	18 19	15 15	13 4	19 16	15 16	12 15
Two-year-olds	25 1	19 6	18 10	27 0	21 13	17 13	26 1	20 19	17 3
Galloway:									
Yearlings	15 7	14 0	...	16 16	.		17 6	14 15	...
Two-year-olds	22 15	21 3		24 13	23 3		24 15	23 10	...
Ayrshire:									
Yearlings	..	...		12 10	8 10	.	13 16	11 18	...
Two-year-olds	.	.		17 0	12 0	.	18 15	14 0	...
Blue Grey:									
Yearlings		.	..	...	.	..	20 10	.	...
Two-year-olds		...	.	...	..	...	.	...	....
Highland:									
Yearlings ...	.	.		...	...		12 15	11 13	9 4
Two-year-olds ...	...		..	...	...	..	16 10	15 15	13 5
Three-year-olds ...	..	..	...	...	..		24 0	22 3	18 0
Dairy Cows—									
Ayrshire:									
In Milk ..	31 18	23 8	14 1	33 11	21 19	14 12	33 14	22 18	14 8
Calvers ...	30 6	23 13	15 4	31 0	24 10	15 11	32 14	24 15	15 5
Shorthorn Crosses:									
In Milk	38 4	27 14	19 4	38 1	28 3	20 6	38 2	29 4	19 15
Calvers	34 16	26 12	18 14	34 6	26 14	18 17	34 14	26 11	18 9
Store Sheep—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	69 5	58 8	45 11	68 0	57 9	45 4	69 11	59 5	40 11
Half-bred Hoggs ...	86 4	67 8	56 6	88 9	76 6	65 6	92 11	75 6	56 8
Blackface Hoggs ...	45 5	32 11	27 0	51 10	38 0	31 1	54 10	43 3	35 5
Greyface Hoggs ...	67 7	55 1	49 8	73 2	62 4	50 8	71 3	59 4	49 8
Down Cross Hoggs	...	...	48 9	...	...	...	..	69 2	...
Store Pigs—									
(6 to 10 weeks old)	31 9	20 6	...	37 2	25 2	...	41 8	26 9	..

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Description.	Quality.	March.			April.			May.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
BEEF :—		per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
Home-fed—										
Bullock or Heifer ...	1	9⅝	9⅞	11½	9¾	10¼	11¾	9⅞	10¼	11⅞
	2	9¼	9⅝	10½	9¼	9⅝	10¾	9½	9⅞	10⅞
Bull	1	8⅝	7½	8⅝	8¼	7⅞	8⅝	8⅝	8⅝	8½
	2	7⅞	7⅛	7½	8	7⅝	7⅝	8	8⅛	7¾
Cow	1	7½	7⅝	7⅞	7¼	7¼	8⅝	7½	7⅝	8½
	2	6⅝	6⅞	6½	6½	6¾	7¼	6½	7	7½
Irish—										
Bullock or Heifer .	1	...	...	10	...	...	10⅛	...	...	10¼
	2	...	...	9	.	...	9½	...	.	9¾
Bull	1	.	...	7½	..	...	7⅝	..	...	7¾
	2	...	...	6⅝	...	...	6⅞	...	...	7
United States & Canadian—										
Killed at Birkenhead	1	...	...	..	..	...	...	...	...	...
	2	...	...	...	...	...	...	...	...	..
,, Glasgow ..	1	..	...	9½	...	...	10¼	...	...	10½
	2	...	...	9	...	...	9¾	...	...	10
Argentine Frozen—										
Hind Quarters .	1	..	6¾	..	...	6⅝	..	...	6¼	.
	2	...	...	...	...	...	...	.	6	...
Fore ,, ...	1	..	5⅝	..	...	5⅛	...	. .	4¼	..
	2	...	5¼	..	...	5	..	...	4	...
Argentine Chilled—										
Hind Quarters ...	1	...	7⅞	8	...	7⅝	7½	..	7½	7⅝
	2	..	7⅝	7½	.	7¼	7	.	7¼	6½
Fore ,, ...	1	...	5¾	5⅝	...	5	4¾	..	4½	4¼
	2	...	5½	5¼	...	4¾	4¼	...	4¼	3¾
Australian Frozen—										
Hind Quarters ..	1	...	...	..	...	...	...	...	...	...
	2	...	...	...	.	...	...	...	...	...
Fore ,, ...	1	..	...	...	...	...	...	...	..	...
	2	...	...	...	...	...	...	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	16	14½	16	17⅝	16¼	16½	17¼	16⅛	16⅝
	60 lb. & over	15	13½	15¼	16¾	15¼	15½	17	15⅛	15⅝
,, Cross	under 60 lb.	16	15⅝	16	17⅝	16⅝	16½	17¼	16⅛	16⅝
	60 lb. & over	15	14⅝	15¼	16¾	15½	15½	17	15⅛	15⅝
Ewes, Cheviot	1	13	12⅝	13⅞	14⅝	...	14⅞	15	...	14¾
	2	12	11⅝	12½	13	..	13⅝	14	...	13
,, Blackface .	1	13	...	13¾	14⅝	...	14⅞	15	...	14¾
	2	12	...	12	13	...	12⅞	14	...	12¾
,, Cross	1	10	..	10½	10⅝	11½	11¼	10	11⅝	11¼
	2	9	...	9⅝	9⅝	...	9¾	9	10¼	10⅛
Argentine Frozen ...	1	...	...	7⅝	...	...	7¼	...	..	7¼
	2	...	...	6⅞	...	...	6¾	...	...	6¾
Australian ,, ...	1	...	7½	...	...	7¼	...	...	7	...
	2	...	7	...	...	6¾	...	...	6⅝	...
New Zealand ,, ...	1	...	...	...	...	...	...	...	7	...
	2	...	...	...	...	...	...	...	6⅛	...
LAMB :—										
Home-fed	1	...	...	...	...	...	...	...	...	...
	2	...	...	...	...	...	...	...	...	...
New Zealand Frozen ...	1	...	13½	12½	...	12¾	12⅝	...	12⅝	12¼
	2	...	...	...	...	...	...	...	12⅝	...
Australian Frozen ...	1	...	11½	...	...	11½	..	...	11½	...
	2	...	11	...	...	...	...	...	...	...
Argentine ,, ..	1	...	11	...	...	10⅝	...	...	10¼	...
	2	...	...	...	...	...	...	...	...	...

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	March. s. d.	April. s. d.	May. s. d.
BUTTER:				
Argentine (Unsalted) per cwt.	1	194 0	186 5	176 0
Australian ... ... „	1	184 0	172 0	171 6
„ (Unsalted) „	1	192 0	180 0	180 0
Danish ... ... „	1	236 3	203 10	187 6
„ (Unsalted) ... „	1	242 3	212 10	193 9
Irish Creamery ... „	1	...	180 0	178 3
„ (Unsalted) ... „	1	...	180 0	178 3
New Zealand ... ... „	1	186 6	175 2	178 3
„ (Unsalted) „	1	192 9	182 10	186 3
CHEESE:				
Cheddar (Old)... ... „	1	116 0	116 0	116 6
	2	110 0	110 0	110 0
„ (New) ... „	1	...	...	93 8
	2	...	...	92 0
Cheddar Loaf ... ... „	1	142 0	142 0	140 6
Canadian ... ... „	1	110 3	110 10	109 0
Dunlop (Old) ... ... „	1	117 6	118 0	118 0
	2	112 0	112 0	112 0
„ (New) ... „	1	...	...	93 6
New Zealand (Coloured) „	1	108 6	108 7	102 9
„ (White) „	1	108 6	108 7	103 0
BACON:				
Ayrshire (Rolled) ... „	1	149 0	153 2	154 0
Irish (Green) ... ... „	1	146 0	142 5	138 6
„ (Dried or Smoked) „	1	154 0	159 2	156 0
„ (Long Clear) ... „	1	150 0	151 7	151 0
Wiltshire (Green) ... „	1	146 0	146 0	144 0
„ (Dried or Smoked) „	1	154 0	155 7	156 0
American, Long Clear Middles (Green) „	1	105 9	111 2	108 9
American, Short Clear Backs ... „	1	108 0	110 0	107 6
American, Sides ... „	1	97 9	103 7	101 0
„ Cumberland Cut „	1	98 0	100 10	98 0
Canadian, Sides ... „	1	104 9	108 10	106 6
„ Cumberland Cut „	1	99 6	106 0	102 0
Danish, Sides ... ... „	1	121 6	131 7	124 6

Description.	Quality.	March. s. d.	April. s. d.	May. s. d.
HAMS:				
Irish (Smoked) per cwt.	1	232 0	232 0	232 0
	2	208 9	207 0	210 0
American, Long Cut (Green) ... ... „	1	110 6	116 0	113 3
	2	...	...	...
American, Short Cut „	1	109 0	112 5	109 6
	2	...	...	...
Canadian, Long Cut „	1	109 0	116 5	110 9
EGGS				
Country ... per doz.	1	1 10	1 3	1 5
	2	1 8	1 1	1 3
Irish ... ... per 120	1	14 6	13 2	14 0
	2	13 6	12 5	12 9
„ (Stored) ... „	1	...	...	...
	2	...	...	...
„ (Duck) ... „	1	17 6	13 10	13 1
	2	16 10	13 4	12 7
Argentine ... „	1	...	...	...
Belgian... ... „	1	13 6	12 11	...
	2	...	12 6	...
Canadian ... „	1	...	...	...
Chinese... ... „	1	13 6	...	...
	2	11 10	..	...
„ (Duck) „	1	14 11	...	...
Danish .. . „	1	16 6	14 9	15 1
	2	13 8	13 3	13 10
Dutch ... ... „	1	13 6	13 0	13 6
	2	...	12 6	...
„ (Pickled) „	1	...	...	...
„ (Duck)... „	1	15 1	12 11	12 3
Egyptian .. „	1	10 3	9 2	8 8
	2	9 8	8 9	8 3
Polish ... ... „	1	...	11 3	10 5
	2	...	10 6	9 8
Russian ... „	1	...	...	10 10
	2	...	...	10 5

Average Prices of Potatoes at Dundee, Edinburgh, and Glasgow.

(*Compiled from Reports received from the Board's Market Reporters.*)

Market.	Quality.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Red Soils. Other.	Other Soils. Langworthy and Golden Wonder.	Other Soils. Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
MARCH.					
Dundee	1	...	...	...	7 15 0
	2	...	...	...	...
Edinburgh	1	...	...	12 10 0	8 0 0
	2	...	...	...	...
Glasgow	1	14 0 0	10 13 0*	12 3 0	9 7 0†
	1	...	...	...	8 4 0*
APRIL.					
Dundee	1	...	...	...	8 4 0
	2	...	...	...	7 10 0
Edinburgh	1	...	...	12 10 0	8 12 0
	2	...	...	...	8 10 0
Glasgow	1	14 7 0	10 19 0*	12 0 0	9 11 0†
	1	...	...	...	8 13 0*
MAY.					
Dundee	1	...	...	...	7 9 0
	2	...	...	...	...
Edinburgh	1	...	...	12 0 0	8 13 0
	2	...	...	...	...
Glasgow	1	14 7 0	10 17 0*	11 17 0	9 17 0†
	1	...	...	...	9 0 0*

* Arran Chief. † Kerr's Pink.

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(*Compiled from Reports received from the Board's Market Reporters.*)

Market.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Barley.	Straw. Oat.	Moss Litter.
		per ton. s. d.	per ton s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.
MARCH.										
† Dundee ...	1	...	24 9	30 0	120 0	...	65 0	65 0	71 3	52 0*
	1	...	...	...	108 9‡	...	...	...	...	...
‡ Edinburgh	1	...	...	...	115 0	...	58 9	50 10	58 9	44 9**
	1	...	..	...	120 0†	...	...	. .	...	41 0§
‖ Glasgow ...	1	...	...	...	90 0	95 0	55 0	. .	50 0	37 6
APRIL.										
Dundee ...	1	. .	27 3	32 11	125 0†	...	59 0‡	57 6‡	58 0‡	52 0*
	1	...	...	...	111 0‡	...	...	...	...	...
‡ Edinburgh	1	...	...	...	115 0	...	55 0	...	55 0	44 0
	1	...	.	...	120 0†	...	...	...	...	...
‖ Glasgow ...	1	...	...	...	90 0	95 0	55 0	...	50 0	37 6
MAY.										
Dundee ...	1	...	...	36 6	130 0†	...	61 3‡	60 0‡	65 0‡	52 0*
	1	...	...	...	117 6‡	...	...	...	...	...
‡ Edinburgh	1	...	...	...	115 0	...	55 0	...	55 0	44 0
	1	...	...	...	120 0†	...	...	...	...	...
‖ Glasgow ...	1	...	...	...	90 0	95 0	54 5	...	49 1	37 6

† Quotations for Hay and Straw, baled and delivered.
‡ „ „ „ delivered loose in town.
‖ „ baled Hay and Straw, f.o.r.

* At Quay.
** Dutch.
§ Home.

Average Prices of Feeding Stuffs at Glasgow and Leith.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	March.		April.		May.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake— Home	13 8 9	12 18 9	13 2 0	12 15 0	12 17 6	12 17 6
Foreign	13 3 9	...	12 17 0	...	12 10 0	..
Decorticated Cotton Cake . .	13 8 9	...	13 4 0	...	13 12 6	.
Undecorticated Cotton Cake— Bombay (Home-manufactured) ..	8 5 0	7 7 6	8 0 0	7 4 0	7 11 3	7 10 0
Egyptian (Home-manufactured).	8 15 0	...	8 8 0	...	8 1 3	.
Palmnut Kernel Cake	9 10 0		8 17 6	..	8 15 0	..
Groundnut Cake— Undecorticated	*10 7 6	..	*9 17 6	..	*9 19 5	..
	**10 14 5		**10 3 0	..	**10 10 0	
Maize Germ Cake— Home .	12 3 9		10 12 6	. .	11 0 0	.
Foreign	11 17 6	.	...		11 6 8	..
Maize Germ Cake Meal		.	11 5 0		10 17 6	
Bean Meal ..	12 0 0	12 6 3	11 19 0	12 5 0	12 0 0	12 5 0
Maize Meal	11 15 0	11 12 6	11 6 0	11 2 0	11 16 3	11 10 0
	‡11 0 0	...	...	...	‡11 10 0	.
Rice Meal ..	8 5 0	.	7 17 6	. .	8 0 0	
Locust Bean Meal .	10 5 0	9 10 0	10 6 3	10 0 0	10 10 0	10 0 0
Locust Beans (Kibbled and Stoned)	.	8 17 6	...	9 2 0	10 0 0	9 0 0
Maize Gluten Feed (Paisley) ..	10 5 8	..	9 10 0	...	9 12 6	
Maize ...	§10 13 9	10 12 6	§10 7 0	10 2 0	§11 5 0	10 12 6
	‡10 15 0		‡10 3 4	.	‡10 10 0	
Oats, Canadian (No. 2 Feeds)	10 15 0	.	10 6 8	..	11 13 9	
,, South African	.	...	9 11 3		10 5 0	
,, Plate .	10 15 8	.	9 19 5	.	10 16 3	
,, Home ..	10 3 9	10 5 0	10 8 0	10 5 0	11 17 6	10 5 0
Barley (Feeding) ...	12 8 9	11 7 6	11 15 6	11 0 0	11 10 0	11 0 0
Barley Bran ..	11 3 4	.	9 10 0		9 0 0	...
Malt Culms... .	9 0 0	.	8 10 0	...	7 17 6	...
Distillery Mixed Grains—Dried	10 0 0	10 0 0	9 19 0	10 0 0	9 2 6	10 0 0
Brewers' Grains—Dried ..	9 15 0	9 3 9	...	9 5 0	...	9 5 0
Distillery Malt Grains—Dried .	9 17 6	...	9 10 8	..	8 10 0	...
Wheat— Middlings (Fine Thirds or Parings)	11 2 6	8 12 6	10 7 6	8 6 0	9 18 2	8 5 0
Sharps (Common Thirds) .	9 2 6	8 10 8	8 2 0	8 2 0	7 16 3	7 17 6
Bran (Medium) ...	9 2 6	8 7 6	8 2 0	7 19 0	7 17 6	7 13 9
,, (Broad) ...	9 7 6	9 5 0	8 7 0	8 11 0	8 3 2	8 8 9
Feeding Treacle ..	8 17 6	9 5 0	8 8 0	9 5 0	8 0 8	9 5 0
Crushed Linseed ...	..	...	30 0 0	...	30 0 0	...
Fish Meal	..	19 0 0	21 0 0	18 12 0	21 0 0	18 10 0
Beans—China ...	10 15 9	...	10 15 0	.	10 16 11	...
English	13 2 6	...	12 10 0	...	12 17 6	...
Morocco	11 13 2	. .	11 7 0	...	11 7 6	...
Rangoon White	10 14 5	...	10 4 1		10 5 0	...
Peas—Calcutta White	12 15 0	...	12 11 3	...	..	..
Dun	11 13 9	...	11 8 9	...	11 16 3	...
Gram—Karachi Red	11 0 0	...	10 5 0	...	10 5 0	...

* 37 per cent. Oil and Albuminoids.
** 40 per cent Oil and Albuminoids.
§ Plate.
‡ South African (Yellow).

Printed under the authority of His Majesty's Stationery Office
By J. Skinner & Co., Ltd., Thistle Street, Edinburgh.
(5222.) Wt. 10321/179. 1626. 7.26. J.S.&Co.,Ltd. G.19.

The Scottish

Journal of Agriculture.

VOL. VIII.—NO. 4.] OCTOBER 1925. PRICE 1s. NET.

THE MINERAL CONTENT OF PASTURES.[1]

Report on an investigation carried out under the direction of W. E. Elliot, J. B. Orr and T. B. Wood at the Rowett Research Institute, Aberdeen, and the Nutrition Research Institute, Cambridge.

THE results of recent research have shown that the mineral content of the diet has a profound influence on the health, rate of growth and productive capacity of domestic animals, and that serious losses occur through the use of rations in which there are marked deficiencies or excesses of one or more of the essential mineral elements, M'Collum (1), Mendel (2), Orr (3). Though most of our information on the effects of deficiencies or excesses of minerals in the diet have been gained from observations on animals being fed on rations consisting chiefly of concentrates, it is known that animals feeding on pasture may also develop pathological conditions due to deficiencies of one or more mineral elements in the pasture.

The mineral content of pasture depends to some extent on the composition of the soil in which it grows. On cultivated land the composition of the soil is affected by the manuring, the main object of which is to supply either nitrogen or mineral elements thought to be deficient in the soil. Hence, there must be a tendency for cultivated pastures to approximate to a common type, which experience has shown to be suitable for the nourishment of domestic herbivorous animals. Indeed it has been suggested by one of us, Orr (4), that chemical analyses would show that the pastures which experience has proved to be of most value for feeding, would also prove to contain the essential mineral elements in the amounts and proportions nearest to those required by the animals feeding on them.

"Uncultivated" pasture grows on soil which has not been treated by the addition of mineral manures, and its mineral content is, therefore, likely to vary widely in different localities. In their natural state, herbivorous animals are free to range over wide areas, and in their choice of pasture are doubtless guided by their appetite to vary their feeding ground, so that in the whole of their grazing there would be no constant deficiency or excess. It is

[1] The expenses of this investigation were defrayed by a special research grant made by the Board of Agriculture for Scotland. The expenses of the investigation of the Falkland Islands pastures were defrayed by a grant obtained from the Colonial Office, on the recommendation of Sir John Middleton, Governor of the Falkland Islands, to whom a separate Report on the Falkland Islands pastures has been submitted.

probable that some of the migrations of herbivorous animals are determined as much by the necessity for the proper quality of pasture in this respect as for quantity.

In the natural evolution of types of herbivorous animals, development in different areas would be towards a type whose size and rate of growth could be supported by the pasture of the area. This idea was put forward over 50 years ago by Brown (5), who showed that the different breeds of sheep in Britain were correlated with differences in the geological formation of the areas where they were found.

From the foregoing considerations it is evident that disturbances in nutrition due to deficiency of minerals in natural pastures would be liable to occur under one of the following conditions:—

(*a*) When animals accustomed to select their grazing over a wide area are confined to a limited range within that area.

(*b*) When a type of animal with a rapid rate of growth reared on cultivated pasture is transferred to a natural pasture which contains markedly less of one or more mineral elements than the pasture on which the type has been evolved.

(*c*) When over a long period of years a grazing area has been depleted in those mineral elements which are used as constructive materials in growth. This occurs notably through animals being reared on the pastures and then sold off without any measures being taken to restore to the soil amounts of minerals equal to those carried off in the bodies of the animals.

As a matter of fact, it is under these conditions that malnutrition in herbivorous animals due to mineral deficiencies has occurred. Thus Murphy (6) records that in certain districts of Australia, when the land was fenced, cattle suffered from characteristic bone lesions and paralysis associated with deficiency of phosphorus, milk cows and growing stock being worst affected. When the soil was fertilised with the deficient minerals, the stock were maintained in good condition.

In the literature are many recorded cases of domestic animals failing to thrive after being transported to new countries and fed on the natural pasture there. One of the most interesting cases is that recorded by Theiler (7), who has shown that deficiency of phosphorus in pastures in the Transvaal limits the rate of growth of young stock and the milk yield of cows in the imported type of cattle being bred. He has also shown that the feeding of bone meal, which is rich in phosphorus, or the phosphatic manuring of the soil, prevents the development of these results of malnutrition. An equally interesting case, which has not yet been recorded in the literature, was reported to one of us (J. B. O.) by a practical expert in charge of a dairy herd in the South of India. The milk yield of imported Ayrshire cows grazed there fell to a low level, and the offspring was stunted in growth. When a suitable mineral mixture was fed to the animals, the young developed at the same rate as Ayrshire cattle in their native country.

It seems probable that the Falkland Islands afford an excellent example of the effects of depletion of pastures. Sheep have been

reared and exported from these Islands for about 40 years, and neither foodstuff nor manure has been imported. During the last 20 years it has been increasingly difficult to rear lambs, and it seems evident from the result of an investigation referred to later that the difficulty can be attributed to malnutrition, the primary cause of which seems to be deficiency of calcium in the soil.

In this country the importance of quality of pasture has been fully recognised. Middleton (8) has shown that the beef-producing capacity of the richest pastures may be as much as forty times greater than the poorest, and the valuable work of Somerville, Gilchrist, Smith and others has shown that the application of mineral fertilisers can improve poor pasture as judged by its feeding value and the change in the predominant type of grasses. But very little work has been done to ascertain whether there is any correlation between the amount and composition of the mineral matter of pastures and their nutritive value. There are some figures available showing the percentage of calcium, phosphorus and potash in different pastures, and Hall and Russell (9) in an interesting investigation compared the amounts of these present in the pasture of the "fatting" and "non-fatting" areas of the Romney Marshes. It is known, however, that amounts and proportions of the other ten or twelve essential mineral elements have a profound influence on nutrition. Thus, either a deficiency or an excess of chlorine affects both health and quality of wool in sheep, Henry and Morrison (10). Deficiency of iron may be the cause of malnutrition in cattle, sheep, goats and deer, and presumably in all ruminants, Aston (11). Too wide a ratio of sodium and potassium produces pathological conditions in cattle, Zuntz (12). Deficiency of iodine may be the cause of the high mortality amongst lambs and young pigs, Ennis Smith (13). With regard to hill pastures we have no information on the percentage of most of the minerals present, and very little even about the percentage of calcium and phosphorus.

It is common knowledge that these natural pastures in some districts produce sheep with large frames and vigorous constitutions, and in other districts produce sheep which, compared with the former, are stunted in growth. It is also known that there are fairly well defined areas of "sound" land and "unsound" land, and there are also some areas on which sheep will remain healthy only for a limited period, after which certain diseases develop. These diseases, however, do not develop if the sheep are periodically grazed for a time on a different area. It is, of course, fully recognised that in many cases endemic diseases are due to parasites, especially those which breed on marshy ground, and also that climatic conditions influence a susceptibility to diseases. There is little doubt, however, that the nature of the pasture is an important factor both in rate of growth and in susceptibility to certain diseases, and it seems reasonable to adopt as a working hypothesis the view that the mineral content of the pasture may have an influence in this direction. This view was supported by the results of work carried out at the Rowett Institute in 1920-21 on the effect of deficiency of certain mineral elements in the food on the health and rate of growth of young animals. These results

corresponded with those of work of a similar nature by M'Collum, Osborne, Mendel and others, which were being applied in practice and which were shown to be of great economic importance.

On the suggestion of Walter E. Elliot, who was co-operating in the work on mineral metabolism at the Rowett Institute, feeding experiments were carried out with hand-fed sheep, and evidence was obtained that certain pathological conditions such as bent-leg were correlated with absolute or relative deficiency of some of the mineral constituents of the diet. It was further suggested by Walter E. Elliot that deficiency of mineral elements in hill pasture might be a cause of malnutrition in sheep, and in 1922 an investigation on the mineral content of uncultivated pasture was begun by him. As the investigation proceeded it became evident that the problem being studied was one of considerable economic importance, and that for its solution a number of allied problems would require to be studied. To enable the scope of the investigation to be widened, Professor T. B. Wood of Cambridge, who had been interested in the work and had been helpful with advice, was asked to co-operate, and since the autumn of 1924 the investigation has been carried out by a self-constituted committee consisting of W. E. Elliot, J. B. Orr and T. B. Wood, the analytical work being carried out partly at the Rowett Institute and partly at the Nutrition Research Institute at Cambridge. In connection with this work, a similar investigation has been undertaken at the request of the Colonial Office into the mineral composition of pasture from the Falkland Islands, where heavy mortality in sheep, thought to be due to malnutrition, has occurred during the last 20 years.

This preliminary report gives only a general outline of the nature of the work done and the results obtained. Detailed accounts of the data upon which the report is based will be published shortly in a series of papers.

Experimental Data.—The investigation included two main lines of work, viz.:—

(A) Analysis of samples of pasture from different areas to determine the percentage composition of the mineral matter, and also a series of samples from some areas collected at three weekly intervals from May to September to determine the seasonal variation in the percentage composition; and

(B) Feeding experiments with sheep to determine the influence of certain differences in the mineral content of the diet on rate of growth and health.

Under "A," samples of pasture were collected from a number of different areas. Samples of herbage "eaten" by the sheep and of herbage "not eaten" were taken separately from each area when possible. The material was plucked by hand, the stems and leaves being nipped off by the finger and thumb. This rather tedious method of collection ensured that the sampling would be carried out over a considerable area, and would thus be representative of the food actually eaten in that area.

The percentage of nitrogen and the "energy value" were

determined in addition to the percentages of the different mineral elements.

Under "B," feeding experiments were carried out with hand fed sheep, and an attempt was made to test the value of supplementary feeding of minerals to sheep on pasture.

A. *Results of Analyses of Pastures.*

In all, 338 samples of pasture were analysed. These included samples from—

(*a*) Typical Scotch, English and Welsh cultivated and natural pastures in different areas.

(*b*) Falkland Islands.

(*c*) Romney Marsh.

(*d*) Samples from some areas to show seasonal variations.

The results are given in averages in the following tables. Table I. shows the results of the analyses of samples of pasture collected in Scotland and England.

TABLE I.

Samples from Scotland and England.—Percentage of Dry Matter.

	CaO.	P_2O_5.	Na_2O.	K_2O.	Cl.	N.	Fibre.	Cals. per 100 gms.	Silica-free Ash.
	%	%	%	%	%	%	%		
Cultivated pasture ...	1·00	0·74	0·25	3·18	0·95	2·83	23·0	268·9	6·64
Good natural pasture, all grazed	0·65	0·67	0·37	2·66	0·64	2·50	24·5	274·8	5·85
Poor natural patures—									
Eaten	0·56	0·60	0·41	2·60	0·60	2·54	25·2	270·6	5·49
Not eaten	0·30	0·37	0·17	1·61	0·33	1·82	29·3	262·9	3·13

It will be seen that there is comparatively little difference in the caloric value of the different samples. There is a distinct difference in the percentages of nitrogen in the "eaten" and "not eaten" groups of the hill pastures. The most marked difference, however, is in the mineral content. The total silica-free ash becomes less as we pass from good cultivated pasture to the "not eaten" hill pasture. The most marked deficiencies are in calcium and chlorine.

At the same time as the pastures were collected, information was obtained locally as to the health and quality of the sheep grazing the pasture from which the samples were taken. This information does not lend itself to statistical analysis, and indeed has not yet been thoroughly sifted. A superficial survey, however, seems to indicate definitely that the highest mortality and the poorest quality of sheep as regards size and constitution are found on the areas where the pastures show the lowest percentage of mineral matter.

(*b*) *Falkland Islands.*—Table II. shows the results of analysis of samples of pasture from the Falkland Islands, where malnutrition amongst sheep has become increasingly prevalent during the last few years.

TABLE II.

Samples from Falkland Islands.—Percentage of Dry Matter.

	CaO.	P_2O_5.	Na_2O.	K_2O.	Cl.	N.	Silica-free Ash.
	%	%	%	%	%	%	
Grass eaten	0·29	0·54	0·31	2·20	0·70	1·95	4·56
Grass not eaten ...	0·14	0·25	0·24	1·30	0·34	1·12	2·45
Grass from near sea ...	0·26	0·54	0·44	1·84	0·56	1.50	4·03
Grass from inland ...	0·16	0·44	0·22	1·74	0·46	1·46	3·43

The results of the analysis of samples from the Falkland Islands show the same general features as those of the British hill pastures. They are definitely poorer in minerals, and especially in calcium, than the British samples. The grass "eaten" is not unlike that of the poorest of the British pastures which were found in Lewis and parts of Argyllshire, and the grass "not eaten" is worse in this respect than any of the British samples. The condition in the Falkland Islands' sheep specifically due to malnutrition, seems, according to a report from Mr. Munro, Commissioner in Agriculture for New Zealand, who has recently visited the Islands, to be, on the whole, worse than that of the sheep in the worst areas of this country.

(*c*) *Romney Marsh.*—Eleven samples were taken from the Romney Marsh pastures. From the "fatting" grass two samples each of the "eaten" and "not eaten" were taken, and from the "non-fatting" three samples each of the "eaten" and "not eaten." Table III. shows the results of the ten paired samples.

TABLE III.

Samples from Romney Marsh—Percentage of Dry Matter.

	CaO.	P_2O_5.	Na_2O.	K_2O.	Cl.	N.	Fibre.	Silica-free Ash.
	%	%	%	%	%	%	%	
"Fatting"—								
"Eaten" ...	0·99	1·01	0·22	4·36	1·39	3·66	19·96	8·66
"Not eaten" ...	0·75	0·65	0·33	2·62	1·00	2·16	28·23	5·58
"Non-fatting"—								
"Eaten" ...	0·90	0·89	0·13	3·62	1·19	3·37	20·22	7·58
"Not eaten" ..	0·73	0·58	0·21	2·69	0·99	1·97	29·02	5·61

The differences between the "eaten" and "non eaten" grasses in these pastures are in the same direction as those found in the hill pastures. The results are different from those obtained by Hall and Russell. This can probably be explained by the method of sampling. These workers collected their samples from a small

"square of pasture" "railed off," a portion of this being "from time to time cut close to represent the grass removed in grazing." If the area chosen by them was on the "eaten" portion in both cases, the results are comparable with the above. It is possible that the difference in nutritive value of the two types of pastures may be accounted for by one of the types having a higher proportion of "non-eaten' pasture than the other. This view seems to find some support in an observation made by Hall and Russell that compared with the "fatting" pastures the "non-fatting" are characterised by greater bulk of stems and flowering heads.

(*d*) *Seasonal Variations.*—Table IV. gives an indication of the nature of the seasonal variation in the percentage composition of the pasture. Fields "A" and "B" in Aberdeenshire are separated by a wire fence. The soil is of the same nature, but Field "A" has been treated with slag and lime. Both fields were grazed during the season.

TABLE IV.

Seasonal Variation in Composition.—Percentage of Dry Matter.

	May.	June.	July.	August.	September.	October.
FIELD "A."						
CaO	·786	·799	1·420	·975	·712	·527
P_2O_5	·780	·787	·702	·653	·702	·659
Cl	·868	1·052	·917	1·144	1·245	1·084
N	2·784	2·678	3·328	2·544	2·489	2·361
Calories	284	264	282	265	269	279
FIELD "B."						
CaO	·526	·517	·563	·709	·624	·645
P_2O_5	·535	·507	·516	·582	·574	·523
Cl	·562	·586	·546	·749	·898	·654
N	1·925	1·830	1·748	1·954	1·956	1·667
Calories	268	261	256	257	256	261

It will be seen that the seasonal variation is greatest in the case of Field "A" which has been treated with mineral fertilisers. It may be noted that since the treatment with slag and lime the beef-producing capacity is from three to four times as great as that of Field "B," though it is reported that prior to the treatment the pastures were of approximately equal value.

Discussion of Analytical Data.—The caloric (or starch) value is fairly constant in all the samples examined. It runs between 260 and 275 calories per 100 grams dried matter. In "non-eaten" samples it was only slightly lower on the average than in the samples from the best cultivated pastures. In hill pastures there is evidently an abundance of material of potential energy-yielding value which cannot be utilised owing to a deficiency or lack of balance of the non-energy-yielding constituents.

The percentages of nitrogen and of all the essential mineral elements are less in the natural pastures than in the cultivated

pastures with the exception of sodium, and in the former are markedly less in the "non-eaten" than in the "eaten" samples. The lowest figures are found in the "non-eaten" samples from the Falkland Islands. Though not shown in the tables it may be stated here that the next lowest were found in samples from areas in Lewis, in the Hebrides and parts of Argyllshire, where the grazing is of very poor quality.

The downward trend in the percentage of mineral constituents appears to run parallel with a decrease in nutritive value. On the pastures with the lowest percentages the number of sheep per acre was lowest, and the health of the sheep, as judged by size and percentage mortality, was poorest.

It is worthy of note that with the exception of sodium there appears to be a definite correlation between the various mineral constituents. A sample which has a low percentage of one constituent tends to have a low percentage of all the others. Various possible explanations of this correlation suggest themselves. One which might be suggested as a working hypothesis for a further investigation is that the amount of one element available may be a limiting factor for the utilisation of others. The results for the Falkland Islands, Table II., and for Field "A" and Field "B," Table IV., seem to afford evidence in support of this view. In the former case analyses of the soil were carried out, and in the latter the treatment of the soil is known. The Falkland Island soils are very poor in calcium, viz., ·126 per cent., and this was the only element which was markedly deficient. Phosphorus and potassium were found in reasonable amounts. The herbage, however, was markedly deficient in potassium and phosphorus, and the lowest percentages were found in those with the lowest percentage of calcium. In the case of Field "A" and Field "B," the former was treated with lime and slag, the latter had no such treatment. But the pasture of Field "A" is richer not only in calcium and phosphorus, which would be anticipated, but also in all the other mineral constituents.

The correlation of calcium and chlorine is interesting in this connection. The soil of the Falkland Islands and of Field "B" and Field "A," which are both on the coast, must be rich in chlorine. The figures in Table II. show that the pasture of the Falkland Island is poor in chlorine, and the percentage tends to run parallel with that of calcium. The percentage of chlorine is also less in the pasture of Field "B" than in that of Field "A," though there is not likely to be any significant difference in the amount of chlorine in the soil of the two fields. In the case of both the Falkland Islands and these two fields, it suggests that the lack of calcium had limited the utilisation of chlorine.

These comparisons suggest that deficiency of one mineral element in the soil may be the cause of the general deficiency of mineral elements in the pasture, either through limiting the absorption of the other minerals by the plant or through limiting the growth and spread of plants rich in mineral elements. If this view be correct, the limiting factor in most of the pastures seems to be calcium. The following Table shows that on the average this is the element most deficient in poorer pasture.

TABLE V.

Amount of Nitrogen and Minerals in different types of Pastures expressed as percentage of amounts found in good cultivated Pasture.

	CaO.	P_2O_5.	Na_2O.	K_2O.	Cl.	N.
Cultivated	100	100	100	100	100	100
Good pasture ...	65	90·5	148	83·6	67·4	88·3
Poor pasture—						
Eaten	56	81·1	164	81·8	63·2	89·8
Not eaten ...	30	50·0	68	50·6	34·7	64·3
Falkland Islands—						
Eaten	29	73·0	124	69·2	73·7	68·9
Not eaten ...	14	33·8	96	40·9	35·8	39·6

It should be pointed out that though, according to our data, in many, and probably in most cases, deficiency of calcium may be the main cause of poverty of pasture, either deficiencies or a lack of proportion may be a factor. Thus in one of the samples of "non-fatting" pasture from the Romney Marsh, the percentage of calcium was about the same level as in the "fatting" pasture, but the ratio of sodium to potassium was about 1 to 900, the next lowest being 1 to 40. Calcium deficiency is only one factor in the problem of mineral deficiency in pastures, though probably the factor of greatest hygienic importance in the areas from which most of the samples of poor pasture collected in the investigations was obtained, i.e., the West Highlands and the Falkland Islands.

B. *Feeding Experiments.*

There is very little exact information available on the mineral requirements of sheep, and the effect of deficiencies or excesses on health and rate of growth. The experiments referred to here are, therefore, of a preliminary nature. They were intended to test whether different proportions of calcium and chlorine in the diet of half grown sheep would be correlated with differences in rate of growth and health. Some data are given for these experiments.

Experimental Data.—*Experiment I.*—This was carried out by Captain Elliot at Lanark (1921-2) to determine whether "bent-leg," a condition similar to rickets which occurs in hand-fed lambs on certain diets, could be prevented by the addition of a calcium salt to the diet. The effect of cod liver oil, which has long been known to be an excellent prophylactic in rickets, was also tested.

Four groups, each of four lambs, were fed on oats, linseed cake, distillers' grain, swede turnips and hay.

Table VI. shows the addition to the ration of the different groups and the average gains in weight in lbs.

TABLE VI.

	I. Ration only.	II. Ration plus Linseed Oil and a Ca. Salt.	III. Ration plus Cod Liver Oil and a Ca. Salt.	IV. Ration plus Cod Liver Oil.
	Lbs.	Lbs.	Lbs.	Lbs.
Wt. at beginning ...	67·8	73·8	72·8	74·6
Wt. after 6 months ...	98·0	99·2	121·7	114·3
Percentage increase	44·5	34·4	67·1	53·2

All the animals in Group I., i.e., the ration only, developed signs of "bent-leg" as had been predicted by the shepherd. No signs of "bent-leg" appeared in any of the other three groups.

Experiment II. was carried out at the Rowett Institute to determine the effects of the addition of oil and various minerals to a ration known to be badly balanced with respect to its mineral content. The ration was of a similar nature to that of Experiment I., though not exactly identical. The results of five groups which are of interest in the present connection are shown in Table VII.

TABLE VII.

	I.	II.	III.	IV.	V.
Additions per head per day	*Nil.*	20 cc. Olive oil	20 cc. Cod liver oil	·5 oz. NaCl	·5 oz. NaCl plus ·5 oz. $CaCO_3$
Percentage increase in weight in 5 months	42·5	38·5	51·6	30·0	52·2

All the animals except those of groups III. and V. ceased to put on weight after the fourth month, and during the last month showed loss of weight and signs of malnutrition. One in Group I. died. The cause of death was diagnosed as "braxy."

Discussion of Feeding Experiments.—The results seem to indicate that both olive oil and linseed oil in the amounts fed in these experiments have a depressing effect on growth in lambs, but that cod liver oil and calcium salts, when added to rations deficient in calcium, have a marked beneficial effect.

It is believed that cod liver oil affects the assimilation of calcium from the intestine, and in experiments with pigs it has been found that the beneficial influence of this oil is most marked when the diet is badly balanced with regard to its mineral content. The ration used contained either an absolute or a relative deficiency of calcium, and its nutritive value for growth was increased when either an additional amount of calcium was added or a factor which increases the percentage assimilation of the calcium present was introduced.

Conclusions.—The information which has been accumulated in this investigation seems to warrant the following conclusions being drawn:—

(1) Marked differences are liable to occur in the mineral content of uncultivated pastures grown in different localities.

(2) Sheep in grazing choose pastures whose mineral content most closely approximates to that of good cultivated pastures.

(3) In most of the pastures collected from the West Highlands and the Falkland Islands the mineral element most deficient was calcium.

(4) Young sheep on a diet deficient in calcium fail to grow at the maximum rate. The addition of calcium salts or cod liver oil to such a diet is accompanied by an increased rate of growth, and an improved condition of nutrition for the animals.

Note I.—The analytical work was carried out under the supervision of Mr. William Godden, the feeding experiments by Captain Elliot and Mr. Arthur Crichton, and the investigation on seasonal variation by Miss Cruickshank. Papers dealing with these branches of the investigation in some detail have been prepared for publication by these workers and will appear at an early date in the *Journal of Agricultural Science*.

Note II.—The writer of this report wishes to acknowledge his indebtedness to Mr. James Thomson, Statistician at the Rowett Institute, who has done all the statistical work in connection with this investigation, and who has rendered valuable assistance in the preparation of this report.

REFERENCES.

1. M'Collum.—Newer Knowledge of Nutrition, 1920.
2. Mendel.—Nutrition: The Chemistry of Life, 1923.
3. Orr.—Nature, 3rd October 1925.
4. Orr.—Trans. Highland and Agricultural Society, 1923.
5. Brown.—British Sheep Farming, 1870.
6. Murphy.—Journ. Dept. of Agric., Victoria, XV., Part VIII., August 1917.
7. Theiler.—Journ. Dept. of Agric., South Africa, 1924.
8. Middleton.—Journ. Min. of Agric., 1922, p. 303
9. Hall and Russell.—Journ Agric. Sc, IV., p. 339.
10. Henry and Morrison.—Feeds and Feeding, 1917, p. 517.
11. Aston.—Trans. New Zealand Institute, 55, p. 720, 1924.
12. Zuntz.—Cited by Armsby, Nutrition of Farm Animals, 342, 1917.
13. Ennis Smith.—Journ. Biol. Chem., 29, 215, 1917.

FARM IMPLEMENTS IN SCOTLAND.

HISTORICAL NOTES.

Professor J. A. SCOTT WATSON, M.C., B.Sc., Edinburgh University.

I.—IMPLEMENTS IN USE BEFORE 1700.

IT would be a difficult task to trace the ultimate origins of all the implements that are now in common use in Scotland. The vast majority have, however, been introduced within the last two centuries, and the few primitive forms that were in existence before that time had remained practically unchanged for many generations. These latter are described in the present article, and the descriptions would probably apply, with quite minor variations according to district and period, to any time between 1300 and 1700.

The shortness of the list that follows is partly accounted for by

the very limited number of crops grown. Potatoes, turnips, clovers and sown grasses were unknown as field crops, the first experiments in their cultivation dating from the early part of the eighteenth century. The staple crops were oats and bere, with small amounts of peas, beans and flax, and in the earlier and more fertile districts some wheat and two-rowed barley. These crops were sown broadcast by hand, were cut with the hook, threshed with the flail and winnowed by means of the wind of heaven.

The Old Scots Plough.—Although at the time in question a good deal of land in the Highlands and Islands was cultivated by means of the Cas-chròm (see p. 363), there seems to be no evidence that this tool was used in the Lowlands. The old Scots plough appears to have been built in all districts according to the same general principles, but there was a good deal of variation in the weight of the materials used, and perhaps still more in the standard of workmanship achieved by the ploughwright. The

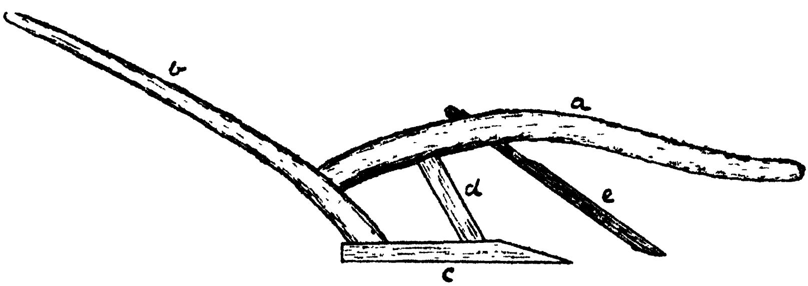


FIG. 1. FRAME OF THE SCOTS PLOUGH.

(*a*) Beam. (*b*) Greater Stilt. (*c*) Head. (*d*) Sheath. (*e*) Coulter.

whole structure, with the exception of the sock, coulter and bridle, was of wood, the various parts mortised and pinned together. The main framework, as shown in fig. 1, consisted of four pieces; the substantial *beam* (*a*) was mortised into the "greater" or left hand stilt (*b*), which in turn was mortised into the hinder portion of what the old writers call the *head* (*c*), the horizontal piece carrying the sock. The beam and head were connected by the *sheath* (*d*), which sloped backwards, making an angle of 60° with the head. The total length of the frame, from the handle of the stilt to the end of the beam, was ordinarily about 13½ feet.

The sock was very long, usually about 2 feet, sharply pointed and without a feather, bearing some resemblance in shape to that of a modern double mould board plough; the furrow slice was thus separated, on its under side, by tearing rather than by cutting. Fixed to the head, and sloping outwards, upwards and backwards from it, was the *wrest*, to which the lower edge of the mould board and the end of the right hand or "lesser" stilt were attached. The head, with sock and wrest attached, are shown in plan in fig. 2. The mould board, which was nearly flat or only slightly twisted, was pinned in front to the sheath, along its lower edge to the wrest, and behind to the right or lesser stilt. The two stilts were connected by a single strut.

The coulter was long and narrow and was always set with a very

pronounced forward inclination. Originally there appears to have been no means of altering the point of draft, the plough chain or *soam* being attached to a simple staple driven crosswise into the

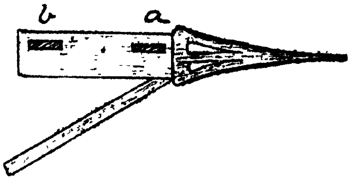


FIG. 2. THE SCOTS PLOUGH—HEAD, SOCK and WREST.
(*a*) Mortise for Sheath. (*b*) Mortise for Greater Stilt.

fore end of the beam; the "land" was adjusted simply by knocking the point of the sock to one side or the other and the depth by knocking it up or down. By 1750, however, an adjustable hake and bridle appear to have been usually added.

The complete implement, as shown in fig. 3, is that described and illustrated by the Rev. Adam Dickson of Duns in his Treatise

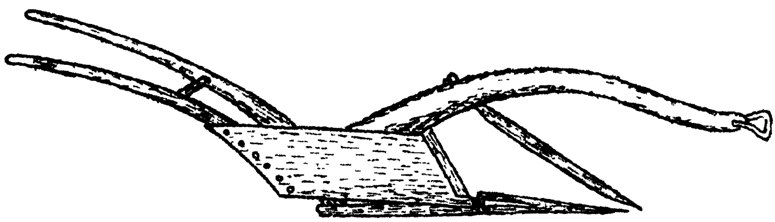


FIG. 3. THE SCOTS PLOUGH. (*After Rev. Adam Dickson.*)

of Agriculture (1762), and probably represents the old plough in its most highly improved form. As representing the other extreme we may take the model shown in fig. 4,[1] which was the type in general use in Aberdeenshire during the eighteenth century, and which obviously left a good deal to be desired in the

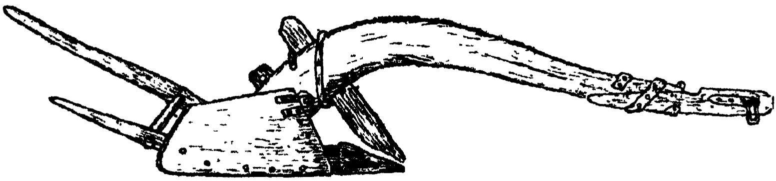


FIG. 4. THE ABERDEENSHIRE "TWAL OWSEN" PLOUGH. (*After Alexander.*)

matter of its construction. Probably most of the models in use were somewhat intermediate between the two—a good deal heavier and cruder than the former, but somewhat better made and less cumbrous than the latter.

Opinions of the efficiency of the old Scots plough among eighteenth century writers are rather varied. The most frequently

[1] From Alexander's "Notes and Sketches of Northern Rural Life in Eighteenth Century."

quoted is that of Dr. James Anderson in his Agricultural Report on Aberdeenshire (1793), who says:—

"The plough itself is beyond description bad; and it is of so little consequence to perpetuate the memory of what can never be imitated elsewhere that I shall omit the description of it. I shall only observe that it makes rather a triangular rut in the ground than a furrow, leaving the soil for the most part equally fast on both sides of it, so that if all the loosened earth were stripped from a ploughed field it would remain nearly in this form ΛΛΛΛΛ, only it would sometimes happen that a gap would be made in these protuberances."

On the other hand Dickson, comparing the old plough with various other types that were coming into use about his time, says of it:—

"When right made it is the best general plough; that is the most proper plough for all purposes where only one is used. Some of the other kinds are perhaps more proper for some particular uses, but none is so fit for all purposes. This may appear surprising to some persons, and therefore it is necessary to observe that by the plough we mean the original structure, form, or plan of the plough, and not this plan ill executed as it is in many of the ploughs in different parts of the country. Because bad tradesmen make this plough heavy and clumsy some persons seem to imagine that this is entirely owing to the kind of plough; but this is unreasonable, for it is certain that this plough may be made as light and neat as any kind of plough whatever."

Similarly Lord Kames in his "Gentleman Farmer" (1776), says, "Of all forms it is the fittest for breaking up stiff or rough ground, especially where stones abound; and no less fit for strong clays hardened by drought. The length of its head gives it a firm hold of the ground and its weight prevents it from being thrown out by stones."

If, however, we base our opinion on the amount and the quality of the work done, in relation to the amount of energy expended, we are driven to the conclusion that the old plough, in its typical form, and by comparison with modern types, was a very inefficient tool. As regards the number of animals required to form a team, it is interesting to note that most of the old Scottish run-rig tenures were based on the assumption that eight oxen were required. The *ploughgate*, consisting of 104 Scots acres, was divided into eight *oxgates* or *oxengang*, the oxgang being thus 13 acres. Two oxengang constituted the normal family holding or husbandland, so that in theory four tenants, each providing a pair of oxen, co-operated in turning out the plough. But as far back as evidence can be found the actual teams varied. Thus in Aberdeenshire as late as the end of the eighteenth century "ploughs of ten or twelve oxen" were common.[1] In the Lothians,

[1] The names of the six pairs of oxen in the Aberdeenshire "Twal owsen pleugh" are thus given in Dr. Pratt's "Buchan." First pair, the on-wyner and wyner; second, the on-steer draught and the steer draught; third, the fore-throck on land and fore-throck in fur; fourth, the mid-throck on land and mid-throck in fur; fifth, the hind-throck on land and hind-throck in fur; and sixth, the fit on land and fit in fur.

during the early part of the eighteenth century, four or six animals, either horses or oxen, but most usually some of each, appear to have been used, and probably some reduction had already been made by that time. The amount of ground covered by such an equipage, managed by from two to four men, was between half an acre and an acre per day, and the quality of the work was distinctly poor.

It must indeed be borne in mind that a great deal of the land was full of earth-fast stones and of strong rooted weeds; also that the draft animals, whether horses or oxen, were small and usually ill fed. As late as 1796, Donaldson in his "Modern Agriculture" bases his calculations of the dimensions of the plough on the assumption that the average farm horse was 15·2 hands high, and the plough cattle, when fattened off at about seven years old, appear to have seldom exceeded 8 cwt. live weight. In the north they were smaller still. But even when all allowances are made, it is clear that there was plenty of room for those improvements in the construction of the plough which were destined to be made by James Small and his successors.

One undoubted advantage that the old plough possessed was its cheapness. Two or three shillings for wood, a like sum for the iron mountings, and usually less than a shilling to the wright for his labour, represented the total cost. More expensive than the plough itself was the iron chain or soam, which stretched from the staple at the fore end of the beam to the yoke of the leading pair of cattle. In Sinclair's "View of the Northern Counties," the value of the plough is put at five shillings and that of the plough soam at six.

The Cas-chròm. — The cas-chròm is an implement of great antiquity, and was in very wide use in the Highlands and the Hebrides up till the eighteenth century. As late as 1811,

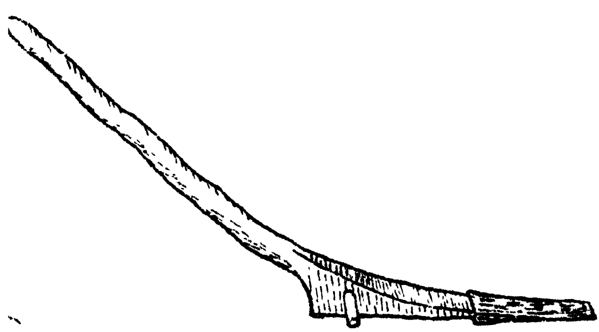


FIG. 5. THE CAS-CHROM. (*After Stephens.*)

according to Macdonald's "Agriculture of the Hebrides," there were still two parishes in Lewis, supporting a combined population of 5000 souls, in which there was not a single plough, and where all the crops were grown on land tilled with the cas-chròm. The implement (fig. 5) consisted of a stout piece of oak or ash, the shaft being about 5 feet 9 inches long. The head, about 2 feet 9 inches in length and usually of the same piece as the shaft, was flattened

and chisel-pointed, and set to the shaft at an angle of about 120 degrees. The point was shod with iron. Into the head, on the right hand side near its junction with the shaft, was inserted a stout wooden peg to which the right foot of the labourer was applied.

In working land with the tool it was driven obliquely into the ground with a double jerk of the foot, and the clod thus separated was thrown over from right to left, the labourer taking a step backwards after turning each successive clod. It is said that with the cas-chròm a good workman could till about a tenth of a Scots acre per day, as against little more than half this area with an ordinary spade. The work was reckoned much more thorough than a ploughing.

Harrows.—The old Scots harrow was rectangular in shape and about 4 feet square. Usually it consisted of four "bulls," each

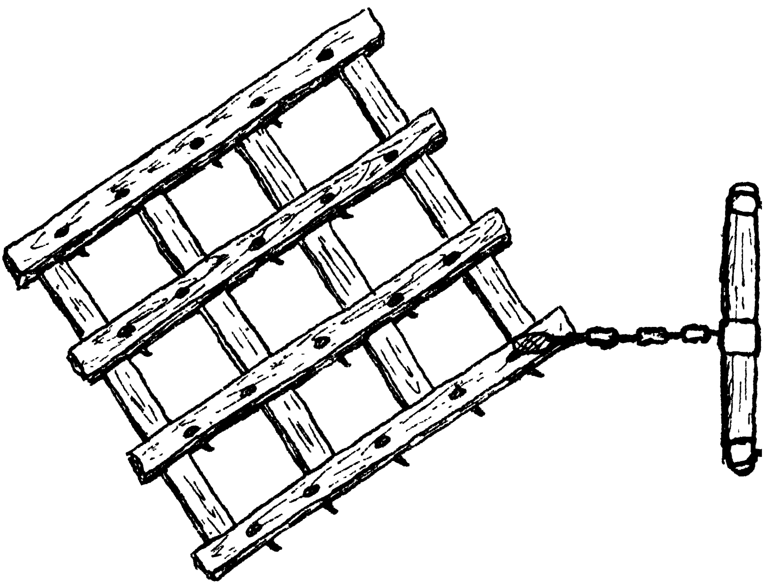


FIG. 6. OLD SCOTTISH HARROW.

carrying five teeth, connected together by four "slots." Originally the whole implement was made of timber, the framework often of birch (as being little liable to split) and the teeth probably of ash. Towards the end of the seventeenth century iron teeth had replaced the wooden in the more advanced districts, but the old, all-wood type, which Lord Kames describes as "more fit to raise laughter than the soil," persisted in many districts till long after.

The harrow was drawn by a corner (see fig. 6) in order that the teeth might each follow a separate track, but it is obvious that the work accomplished must have been very unequal, the middle portion of the ground passed over receiving most of the effect, while the edges were left but very imperfectly tilled. Each harrow was drawn by a single horse, but usually two were driven abreast by one man.

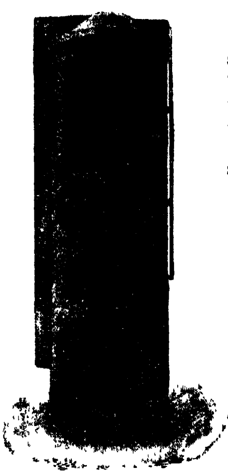
In many parts of the country, particularly in the north and

THE "SCOTT" SILO

— OF —

Reinforced Concrete

IS UNEQUALLED FOR QUALITY & PRICE.



It is the Best and Cheapest Ensilage store-house that has yet been offered.

The "SCOTT" Silo requires no maintenance; is proof against wind, storm and vermin.

We are now Agents for the

"PAPEC" ENSILAGE CUTTER

and stock all Spares. This cutter is a little wonder; costs less money to run than other cutters, goes through more work, and does not choke.

JAMES SCOTT & SON
(ABERDEEN), LIMITED,

483-485 Union St., ABERDEEN.

"ACME" HORSE CLOTHING WAREHOUSE.

SPECIALITIES:

Twines,	Horse Clothing.
Cotton, Hemp,	Waterproof Covers.
Jute, &c., &c.	Tarpaulin Covers.
Box Cords.	Carriage Lamps.
Ropes of all kinds.	Carriage Rugs.
Engine Packing.	Harness Composition.
Bullock Ropes.	Dandy, Body and
Tackle Ropes.	Stable Brushes,
Splicing attended to.	&c., &c.

JOHN PURDON,

58 Howard Street,

GLASGOW.

Telephone No. 5678 Central.

Interest yourself in

FRENCH POTASH

FOR ALL YOUR CROPS.

KAINIT, (14 %) **EXTRA KAINIT,** (20 %) **POTASH SALTS,** (30 %)

MURIATE AND SULPHATE OF POTASH.

Supplies from
THE ABERDEEN LIME CO., Aberdeen
J. & J. CUNNINGHAM LTD., Dundee, Leith, Berwick
ALEX. CROSS & SONS, Glasgow
and Branches.

Leaflets and Information from—

J. GORDON, B.Sc. (Agr.), French Potash Mines, 137 GLASGOW ROAD, PERTH.

west, it seems to have been common to yoke the horse simply by tying its tail to the harrow, and although the practice was expressly condemned by the Privy Council it continued in use in the Western Isles till well on in the nineteenth century.

Grubbers are not mentioned by any of the old writers, and the only other implement used for stirring the soil was the break harrow, built on the same lines as the last, but heavier, with fewer teeth and requiring two or three horses to draw it. Even this seems to have been rare.

Rollers.—Rollers were known in Scotland before 1700, but it is certain that, taking the country as a whole, only a very small proportion of farms were equipped with them. Lord Kames (The Gentleman Farmer) says, "The roller is an instrument of capital use in husbandry, though scarcely known in ordinary practice, and where introduced it is commonly so slight as to have very little effect." Similarly Brown of Markle in his admirable "Treatise on Agriculture and Rural Affairs" (1811) speaks of rolling as a modern improvement. That it was not more common is less surprising if we remember that none of the small seeded species of crops (like roots and clover) were grown, so that the need for a particularly fine or firm tilth scarcely arose. Also when cereals were all shorn with the hook there was no absolute necessity to secure a flat surface after sowing.

The old types of roller were usually made from the solid trunk of a tree or of stone, but Dickson also mentions the wooden sparred type. Previous to the eighteenth century the cylinder was always in one piece, but about 1750 the idea of dividing it in two, in order to remove the inconvenience in turning, was introduced.

Barn Implements.—Up till 1787 the only means of threshing grain was by the flail. In some parts of the Highlands, indeed, the operation was avoided altogether by the expedient of setting fire to the sheaves, whereby the straw was disposed of, and the grain "kiln dried" ready for milling, in a single operation. This, however, was exceptional.

The flail requires no elaborate description. It consisted of two strong sticks known respectively as the hand staff and the souple, hinged together by leather thongs. Threshing with the flail was a laborious and irksome task, unpopular with the worker, and demanding close and constant supervision on the part of the farmer. With the grain stacked ready in one end of the barn, and with occasional help in shaking and removing the straw, a good workman could thresh about a quarter a day. Even at the best it was reckoned that five per cent. of the grain was lost and a further proportion broken or otherwise damaged.

As regards winnowing, no method had been thought of except that of utilising natural wind. The operator stood between the two opposite doors of the barn and dropped the grain from a kind of sieve at a rate proportionate to the strength of the wind. Naturally the threshed grain had sometimes to lie for a week or more before suitable weather was obtained.

Carts, etc.—In most parts of the country carts were scarcely used before 1700—not because they were unheard of, but because their introduction had to await the making of passable roads. In

1687 the first Earl of Strathmore, then building Glamis Castle, had to send to St. Andrews for wheels to his stone carts, there being no capable wheelwright nearer hand.

For the most part goods were carried on horseback. For heavier materials, such as dung, a pair of hazel wicker-work creels or currachs, hung one on either side of a crook saddle, were used. "In loading it was needful to fill the two currachs simultaneously to keep them balanced. When one man filled more promptly than his fellow, he gained an advantage in depressing his own creel and correspondingly elevating that on the other side of the horse. Hence the phrase 'coupin' the creels' upon one came to be a sort of byword."[1]

Corn was brought in from the field in semi-circular hurdles or frames attached to the pack saddle in the same way as the creels; or sledges might be used. Grain was taken to mill or market in sacks slung over the horses' backs, and if a large quantity had to be carried the horses were tied tail to halter in a long string, with a driver in front and another behind.

Such carts as were used were small tumbrils made entirely of wood. The wheels were from 18 inches to 2 feet in diameter, and consisted of three sections of solid plank fixed together and rounded like the end of a cask. The axle tree revolved with the wheels, and was kept in place by means of two pins of wood inserted upwards into the hinder end of each of the shafts. Such a vehicle seems to have been capable of a load of perhaps 3 cwts., and although its life, or at least that of its wheels, was short, and its un-greased progress was anything but silent, it was regarded as a considerable triumph of mechanism. The merit of cheapness it shared with the plough—half a crown and six and eightpence being two separate estimates of its cost.

THE WOOL INDUSTRY IN SCOTLAND.

I.—PRODUCTION.[2]

J. A. McMillan, B.Sc.,
Department of Agriculture, Leeds University.

THERE still remains much to be learnt of the early history of those sheep that gave rise to our modern breeds. Numerous attempts have been made to piece together a concise description of the origin of the sheep of these islands from the somewhat limited writings of ancient historians and from the information derived from discoveries of remains and relics, and to trace how present-day types have been developed. It is known from later history, however, that the sheep existing in this country at the time of the Roman invasion were being used to provide both meat and

[1] Alexander's "Notes and Sketches."

[2] In the next issue of the JOURNAL, to be published in January 1926, will appear a second article, by Professor A. F. Barker, Leeds University, dealing with the utilisation of the wool.

clothing, and, since then, there is ample evidence of the usefulness of this native sheep and of the improved types of later periods. Only to a limited extent does the sheep seem to have been used in this country for milk production.

Improved Types of Sheep.—The outstanding feature of the native sheep appears to have been their ability to exist under extremely adverse climatic conditions, a characteristic no doubt developed through the survival of the most hardy and the gradual elimination of those types which proved themselves less suitable for their environment. The great value of this early natural selection can be appreciated truly, only when it is realised that there is a considerable proportion of the blood of this hardy stock in the sheep that graze large areas of the bleakest land in Scotland, land so situated and so poor as to be unfit to maintain with profit any other kind of farm live stock. Even until some two hundred years ago by far the greater part of the sheep of the Highlands and Western Islands of Scotland were of an essentially primitive type, being hardy, small, thin, long in the leg compared with their depth and length of body, and carrying short wool of varying colour. Though a similar type is found still in the more outlying districts, the general character of the sheep of both the hilly and the lower lying parts of Scotland has been changed, chiefly through the introduction of imported rams which were crossed with the native sheep.

There are records showing that Merino rams from Europe were imported at various times between 1400 and 1850 with the object of improving the quality and the quantity of wool produced by the existing sheep of that period. That an effort to improve wool and increase its production in Scotland should have had precedence over an effort to secure better mutton seems a little strange to those intimate with sheep farming in this country during recent times, but then it should be remembered that unmanufactured wool was the principal export of Scotland in the Middle Ages. At a later period, through the exertions of a number of enthusiastic gentlemen who grouped themselves together and worked under the name of the British Wool Society, Ryeland rams were imported from England. These were used to improve the wool of the Cheviot breed, a breed which at that time the members of the society thought the best in Scotland from the point of view of wool production. This introduction had a distinct influence in improving the quality of the fleece of the Cheviot, making it closer and giving greater uniformity in its different parts, but apparently without increasing its weight. The failure to secure a heavier fleece is not surprising, as the Ryeland of that time was very different from a modern representative of the breed, being smaller in size and yielding a smaller weight but a finer quality of wool than is now the case.

There is little evidence of any systematic attempt to improve the sheep of Scotland from the point of view of mutton production and of early maturity, until the results of the breeding of Leicester sheep by Robert Bakewell became known. This improvement really dates from a time towards the close of the eighteenth century, when rams containing a high proportion of Dishley-

Leicester blood were brought from England. Careful selection of the progeny by these rams and of that of subsequent matings by a few progressive breeders did much to raise the general standard of a fair proportion of the sheep of the country as mutton producers, and other breeders, even though they did not use imported rams, began to pay greater attention to the selection for mutton points. In the course of time the use of rams containing some Dishley blood became much more general, and their influence in giving earlier maturing types much more widely felt.

Though selection did and still does play a most important part in the improvement of all classes of stock, it is not possible to attribute the whole of the improvement of mutton and wool qualities to this alone. The profitable maintenance of the more highly improved breeds of the present day has been made possible by an advance in knowledge of the management of land and of crops, while the early maturity, developed in breeds formerly termed slow maturing, is due not only to the improvement of these breeds, but also to better management and to the use of more suitable food.

Sheep Population of Scotland.—At present there are just over 7,000,000 sheep in Scotland, which is about the normal pre-war number. In the year 1920 the sheep population was the lowest it has been for many years, amounting to 6,350,000, but since then the number has risen each year.

Comparison of the relative numbers of sheep and cattle in Scotland with those in England and Wales brings out the rather surprising fact that, whereas in Scotland there are almost six sheep to every head of cattle, in England and Wales there are only about two and a half. To a large extent the relatively high proportion of sheep in Scotland is consistent with its high proportion of hill land, but this does not explain why the relative number of cattle to sheep is increasing in England and Wales, whereas in Scotland it is decreasing. It is probable, however, that the cattle population in certain districts in Scotland could be increased with advantage to the securing of an increase in the sheep population. There are many wide areas in the Blackface and Cheviot country where the sheep-carrying capacity of the land is becoming reduced year by year on account of the encroachment of bracken on good grazing land. Some farms carrying the same stock as they did twenty or thirty years ago are overstocked now, though they were not then, a state of affairs chiefly attributable to the spread of the bracken. Nor does the loss of grazing represent the whole damage due to this pest. There must also be added the loss of sheep, struck by the fly or ill, that crawl into the bracken in a weak state and remain there to die, being hidden from the shepherd. The increase of the bracken has followed the abandonment of the practice of summering cattle on land suitable to its growth, or at least to reducing the head of cattle carried very considerably, but, because of the slowness of the change in the vegetation, little attention has been given to the cause. With the labour available in outlying districts, it may be difficult to restrict the bracken solely by cutting. The summering of an adequate head of cattle, however, does seem to present one prac-

ticable method of checking the increase of the bracken, and of even opening up fresh areas for the sheep to graze.

Overstocking, especially with sheep, is disastrous, but it does not appear as if this stage had yet been reached in Scotland. It is admitted there is much land which it would not pay to improve at present, yet there is also much which could be improved so as to carry a much greater head of stock with profit both to the country and to the individual.

Breeds of Sheep in Scotland—Only about a third of the many breeds of sheep found in Great Britain are represented in Scotland. In the following description of these breeds only a few special features of each are mentioned. Fuller descriptions have already appeared in this Journal[1] and elsewhere.

Blackface.—The Blackface and the Cheviot are the most important breeds in point of numbers and of general distribution. The superiority of the former for the wide tracts of the highest hills and for heath land is well established, but it is found also on the lower ground, where pure-bred flocks or ewes suitable for crossing are kept in large numbers. The breed exhibits a good deal of variation according to the different districts and conditions where it is found. These variations have arisen in most cases through a series of continual but gradual changes, by which types have been evolved better suited to their surroundings, and have shown themselves most clearly in differences in size, in hardiness and in the character of the wool.

The chief feature of the more recent history of the breed is concerned with the development of earlier maturing types to meet the demand for small and lean mutton. The demand for store lambs has grown enormously, and these to-day are selling at prices very much higher than those given for three or four year old wedders in pre-war days. The latter class of sheep are now seldom seen, and the number of two year old wedders is greatly reduced. More attention as a rule has been given to improving the mutton qualities of the breed than has been devoted to the development of good wool. Thus the wool, very variable in the original parents of the breed, has remained irregular in quality. This is discernible not only in comparing different fleeces, but in comparing different portions of the same fleece. The average weight of the fleece has remained more or less constant for a considerable period.

Any effort to improve the breed must of necessity be undertaken with great care, lest in effecting an improvement the hardiness for which the breed is famed should become impaired. As an illustration of the endurance and hardiness of the Blackface, mention might be made of a case known to the writer, where a ewe, buried in a snow wreath for twenty-nine days, gave birth to a lamb six weeks after being released, and reared the lamb without any help in the form of artificial food except a little natural hay. It can be understood that under the conditions that hold in that particular district, any attempt to increase the size of the sheep would very probably mean disaster, nor could the length of the

[1] See JOURNAL, Vol. IV., No. 4, Border Leicester Sheep; Vol. V., No. 1, Cheviot Sheep; Vol. V., No. 2, Blackface Sheep.

wool be increased greatly without seriously handicapping the sheep for travelling in the snow. On the other hand, the selection of lambs to be kept as rams could be undertaken in a much more thorough manner than is sometimes the case. Instead of selecting the biggest and strongest lamb, irrespective of its breeding, an effort should be made to select lambs from parents proved to be hardy and good breeders, showing those mutton points that are desirable and yet having a good covering of uniform wool, especially below, as this is regarded as an indication of their power to keep the back wool. There would seem to be little hope of ever producing from the highest hills a very fine fleece quite free from kemp, for under the trying conditions the proportion of kemp in the fleece tends to increase as the sheep ages, but there is little doubt that much could be done by proper selection to improve the general character of the wool and increase its bulk without a loss of hardiness

The type of Blackface produced by breeding successive generations on the lower and better land, is obviously ill suited for the poorest conditions. Demands, however, do exist for a type of Blackface showing size, early maturity in a more marked degree and carrying a heavier fleece of fine wool, and yet not too delicate in constitution. In the absence of such a type the Swaledale breed is spreading steadily on hill and moorland in certain districts of the north of England, where the Blackface only a few years ago was supreme.

Cheviot.—Although to-day the Cheviot is thought very highly of both as a mutton and a wool producer, this was not so when the breed was in its infancy. The early esteem in which the breed was held was due to its ability to produce wool much superior to that obtainable from any other breed in Scotland. The Cheviot of to-day can hardly be reckoned a serious competitor of the Blackface, it being essentially a sheep more suited for green hills and less suitable for the heather land. At various times, particularly when wool prices have been high, attempts have been made to introduce the Cheviot into districts previously stocked by the Blackface, but, though generally successful for some few seasons, these efforts have proved a failure in the end on account of its inability to withstand the rigours of the most severe winters on the harder ground. It was shown also by these trials that the wool and mutton qualities of the Cheviot deteriorated under the poorer conditions.

To the use of imported rams, referred to previously, must be attributed the chief credit for the improvement in Cheviot wool and the quality of early maturity possessed by the present representatives of the breed. These improvements undoubtedly were the main influence in securing for the breed the popularity and the widespread distribution which it now enjoys. That hardiness and activity, so characteristic in all true mountain breeds, have not been lost through the too free use of foreign blood is a matter of which Cheviot breeders are justly proud. It is known there were times when the loss of vigour and constitution were threatened, but fortunately these features have still been retained. It would be a pity indeed if the experience of these past trials were not

taken as a guide to any future work of improvement that may be undertaken. So long as the hardiness, quality of carcase and good wool of the best type of Cheviot are maintained by careful selection of the breeding stock, it seems certain that sheep of the breed will remain in active request.

Border Leicester.—This breed deserves recognition as one of Scotland's leading breeds, not so much on account of its numbers compared with the Blackface and the Cheviot, as on account of the widespread distribution of Border Leicester rams for crossing with ewes of the Blackface, Cheviot and Half-Bred breeds. Some idea of the breed's distribution in Scotland can be gathered from the following particulars which relate to the counties where registered flocks are found and to the number of such flocks in each county:—Aberdeen, 61; Lanark, 35; Ayr, 25; Forfar, 24; Perth, 16; Dumfries, 14; East Lothian, 13; Berwick, 11; Fife, 10; Roxburgh, 10; Kincardine, 8; Ross, 8; Wigtown, 8; Midlothian, 7; Banff, 5; Peebles, 5; Kirkcudbright, 5; Caithness, 4; Renfrew, 4; Inverness, 3; Linlithgow, 3; Moray, 3; Kinross, 1; Stirling, 1.

Directly descended from the Dishley Leicester, the Border Leicester was not recognised as distinct from the English Leicester until the latter half of last century. A typical specimen of the breed is clean in the leg, beautifully symmetrical in the body, with a well carried head and stylish carriage. Further, the head is neat, a feature which admits of rams of this breed being used on ewes of small breeds with the minimum of risk.

Half-Bred.—The Half-Bred (Border Leicester X Cheviot) as a breed is unfortunate in possessing a name so generally in use to denote half-breds produced from parents other than the Border Leicester and the Cheviot. Now that the breed has become so well established and so widely distributed, it would seem desirable that half-bred breeders should adopt a distinctive name, so as to ensure a wider acceptance of their sheep as being of a definite breed. In certain districts in England much confusion is caused through the use of the name half-bred.

The breed has existed for at least a hundred years, and during that time it has spread steadily, until half-bred ewes and ewe lambs can now be found from the north of Scotland to the south of England. In England a number of the ewe lambs are put to a ram of a small breed in their first year. The ewes cross well with most of the Down breeds and with long woolled breeds such as the Border Leicester, the Leicester and the Wensleydale.

Down Breeds.—One of the most interesting changes in the sheep farming industry of Scotland concerns the use of rams of several of the Down breeds and the establishment of an increasing number of registered Down flocks. For some considerable time there has been a very limited number of Down rams in use, but it is only since the beginning of this century, and more particularly since the war, that their use has become general. The demand for lean and small mutton was undoubtedly one very important factor in influencing this change in the use of sires. The sires most frequently employed are the Oxford and the Suffolk, and less frequently the Shropshire and the Hampshire.

Oxford Down.—The pure bred Oxford Down is represented

in Scotland by 30 registered flocks, distributed as follows:—Roxburgh, 8; Berwick, 8; East Lothian, 7; Aberdeen, 2; Fife, 2; Midlothian, 1; Forfar, 1; Lanark, 1. These flocks, containing some 2000 ewes, do not, however, give a true indication of the extent to which rams of this breed are used for crossing. At a large number of those markets surrounded by wide areas of medium or low lying land, Oxford cross store lambs predominate, and are in sharp demand.

The Oxford Down sire has become appreciated chiefly through his power of transmitting his own good features to his offspring in a marked degree. The breed is hardy, the largest of the Downs, and gives sheep capable of making good weights at an early age and of yielding a good quality carcase. The wool though short is longer and coarser than that of any of the other Down breeds.

Suffolk Down.—There are at present 34 registered flocks in Scotland distributed in 14 counties as under:—Roxburgh, 7; Dumfries, 5; East Lothian, 4; Aberdeen, 3; Perth, 3; Fife, 2; Forfar, 2; Berwick, 2; and one each in Inverness, Kirkcudbright, Lanark, Linlithgow, Ross and Wigtown. These contain some 2000 pedigree ewes.

In appearance the Suffolk Down is distinctive from the other Downs, owing to the entire absence of wool on the face and legs, which are of a uniform black colour. It does not attain to the size of the Oxford, but is possessed of a compact body and of a head not so wide as to preclude its safe use with the older ewes of even the smaller breeds.

Shropshire Down.—The pedigree Shropshire is represented by two flocks in Scotland, one in Forfarshire and one in the Orkney Isles. The use of the Shropshire sire in Scotland is much more limited than that of the Oxford and the Suffolk. One reason for this is that the close fleece of the Shropshire cross bred deceives a buyer as to the sheep's true size, when he compares it with the more open fleeced cross bred by an Oxford sire, and in consequence the Shropshire cross is placed at a disadvantage. The risk of using a Shropshire sire with ewes of a small breed is also greater, particularly with the older type of Shropshire with a wide head.

Other Breeds.—The Shetland and the Soay, breeds of very local importance, are known chiefly through the high reputation of the fine quality of the wool which they produce. The yield of wool per sheep is very small, varying from a pound or two upwards. Neither of the two breeds is built on the lines suitable to yield a carcase full of meat in the best parts, but the quality of the mutton is very good.

The Relative Importance of Mutton and Wool.—The results obtained by plant and animal breeders and the value of their work are well known. Some evidence of the value of this work is provided in the mention of such features as the production of cereal varieties capable of giving high yields of grain and yet possessing strong straws, the production of dual purpose cattle, and the raising of breeds of sheep efficient both as wool and mutton producers. In the formation of a large number of the modern breeds of sheep, two distinct types have been used, namely, a hardy type giving mutton of excellent quality, and a less hardy type, producing fine

wool but showing poor mutton points. It has not been possible so far to produce the very finest quality of wool and the best mutton in the one sheep, nor does it seem likely that such a type will ever be bred, there being other external factors apart from the sheep itself which would influence either the wool or mutton adversely. There is, however, wide scope for improvement, so that the best may be made of any given set of conditions.

Reference to records brings out the lack of relation between the movements in mutton and wool prices. When wool has been very high in price, mutton has not necessarily been very high or very low, and there have been times when both wool and mutton have been low. Expressed from rather a different viewpoint, this has meant that a farmer, who derived his sole income from sheep, could not be certain whether, if his income from wool failed, his returns from mutton would help him through, or *vice versa*. It is natural under these circumstances that he would concentrate more on that commodity which was the more stable in price and which could be produced better under the conditions of climate and soil in his district. Briefly, this has meant that for a very considerable period more attention has been given to selection for mutton rather than wool points over the greater part of Scotland. Wool, though still regarded as a valuable source of income, in the main has been left to look after itself. There certainly have been times when rises in wool values have influenced farmers to try to increase their output of this commodity, but generally chief consideration has been given to the securing of a superior type of mutton sheep. Many breeders have been guided by their beliefs that their land, which would support sheep yielding the highest quality of mutton, was incapable of carrying sheep which would produce an abundance of fine quality wool, whereas, though wool of much superior quality could be obtained from several of our colonies, mutton from the same source did not attain to the same degree of perfection as that produced at home. Further, the sheep farmer, keeping non-pedigree stock, has been forced to the conclusion as a result of his experience that his chances of a profitable return arising from an improvement in the mutton points of his sheep are much greater than those to be obtained from the expenditure of effort in improving the quality of the wool produced. In fact under the general system of selling the wool of mountain flocks at present in vogue, the only difference in money returns between a breeder who has devoted much time and trouble to improve his wool clip and one who has neglected this side of the business, generally is small, and is due more to an increased weight of wool than to any higher price per stone received on account of its improved quality. It seems likely that the average producer will delay putting forward any sustained effort to improve wool until he can see some definite hope of being rewarded for his labour, and he on his part cannot hope to receive a higher return until the wool is marketed in a condition more pleasing to the manufacturer. Greater attention will require to be given to the removal of the dirty portions of fleeces, to the more thorough grading of the fleeces from the different classes of the stock, and to the elimination as far as possible of stains and of vegetable matter from the wool. It must

be borne in mind that, even though the quality of the wool of a certain flock were greatly improved in length, fineness, uniformity in the fleece and in freedom from kemp, yet unless it were marketed in good condition it is very questionable if it would command a higher price than it would have done in its unimproved state.

The demand for small mutton has had the indirect effect of reducing the quantity of wedder wool produced, the two classes of sheep now supplying most of the wool being the hogg and the ewe. Hoggs generally yield a heavier and a finer fleece than ewes, and young ewes give a better return in wool than old. Under present methods of sheep farming both wedder and ewe hoggs receive sufficient food to prevent the development of weak portions in the wool fibres that might result from starvation. Such weaknesses are found only in the fleeces of those which have suffered from ill health at some period in their early life. With ewes, conditions are rather different. Starvation and long periods of exposure to severe conditions leave their mark more particularly among those living on hill land, and apart from weakening the wool fibres, such periods of stress followed by better conditions result in some portion of the fleeces being cast and possibly lost. At the season when starvation is most likely to occur these ewes are usually heavy in lamb, and consequently in need of rather more food than when not pregnant. Thus the strain is felt more severely. It is during such critical periods that much can be done, by careful shepherding and the provision of a little natural hay, to prevent the ewes becoming too reduced in condition to do themselves justice at lambing time, or to yield their owner a reasonable quantity of wool.

The favour for young mutton, as contrasted with that obtained from two, three and four year old sheep, also has had an indirect influence in reducing the quantity of wool produced from hill flocks. Hill sheep farmers in large numbers have changed from wedder to ewe stocks to meet the changed demand. In such cases the loss of wool, sold as wool, is represented by the loss of weight of wool obtained from the one, two, three and occasionally four year old wedders formerly kept, and the gain in weight due to the extra ewes added to the stocks. That this gain does not balance the loss is a matter of common knowledge, but with the good prices ruling for wedder lambs in recent years, it is a loss which has not been felt to any appreciable extent by the producer. There seems little prospect of present mutton prices lasting very much longer. When a serious drop in price does occur, it is possible many sheep farmers may regret that they went in for a complete change, or at least that they did not pay greater attention to wool points in the selection of their breeding rams.

The typical mountain flocks, though still the chief contributors to the home grown wool supply, do not now yield so high a proportion of the total as formerly. In certain districts the greater part of the wool produced comes from the Border Leicester and its crosses, while in others the advance of the Down breeds and the increased use of Down sires has resulted in a larger production of finer and more valuable wool.

It is acknowledged by animal breeders that the more highly improved their stock becomes, the more difficult is it to maintain that standard of improvement, and that, if they do not continue to strive further to improve the stock, then the improvement is easily lost. This applies to wool as to other qualities. It seems strange to read of the Cheviot of two hundred years ago yielding on an average a fleece of two pounds. Now a breeder would be disappointed if his ewes did not yield more than twice that weight. Here is an instance of what suitable introductions followed by careful selection have achieved, and an indication that the Cheviot, as far as wool production is concerned, is an improved breed. Is it possible to say that even now the economic limit of wool production has been reached? If it has, it certainly will not be maintained unless use is made of the best woolled sheep as sires, not only now and again when wool is high in price, but regularly year by year.

Modern breeds of sheep are all improved types, and most are what may be termed dual purpose types, that is mutton and wool producers. Very high prices for one or other of these commodities usually only hold for a comparatively short time, and thus it would seem a mistake to lose sight of the importance of either, for it is due to both these products, and not to either one or the other, that the sheep farmer of Scotland has been able to weather the leanest times.

The Value of Home-Produced Wool to Agriculture.—Directly and indirectly home-produced wool has exerted a most marked influence on the agricultural development of Scotland. Prior to the springing up of an active demand for wool to export, the sheep population was small and was confined to limited areas clear of the forests, which covered much more land than they do now. The sheep population increased considerably following the realisation that wool was a profitable commodity to produce for export, sheep farming became an occupation of a larger number of persons, and wool became the leading export of the country. It was found necessary to clear considerable areas covered with woods to provide more land for grazing the increased number of sheep and to allow of each individual obtaining sufficient land for his flock. That this expansion of the sheep-farming industry has not been maintained through the succeeding centuries is well known. It is interesting, however, to recall that, as a direct result of the development of the wool trade, large areas of land were cleared, and an increased number of persons derived their income from sheep farming, features which had an important bearing on the future of agriculture in Scotland.

At the time of the development of the wool export trade, mutton did not occupy the position it does to-day. Artificial foods and roots, which are now so largely used for winter feeding, were unknown. All the mutton produced came from sheep fattened at grass in summer, and the meat consumed in winter was obtained from carcases that had been preserved with salt. To-day, of course, it is the exception to find a medium or light land arable farm where sheep are not fattened in winter, folded on roots. On a considerable proportion of such land, sheep no doubt were the forerunners of the plough long ago.

The early importance of home-produced wool has rather been overshadowed with the industrialisation of this country and the comparatively recent development of sheep farming in Australia, New Zealand and South Africa. Yet it must not be forgotten that there are several manufactured woollen goods for which imported wool is unsuitable, and many others for which a mixture of home grown and foreign wool is desirable. There is also the prospect that, as the result of research, new uses may be discovered for home produced wool in the future. It is indeed all the more important that attention should be given to maintain and improve the quality of home grown wools, now that the competition has become more keen.

THE BIOLOGIST ON THE FARM.—No. XIX.

By Professor J. ARTHUR THOMSON, M.A., LL.D.,
University of Aberdeen.

Relics in the Sheep.—Professor Philip J. White of Bangor has always been keen on the search for antiques, and he has been recently studying the small bones in the sheep that lie behind and towards the lower end of the cannon bone. They seem to be the vestiges of the second and fifth metacarpals. The upper end of the fifth metacarpal is generally seen as a splint or spike of bone, attached to, and sometimes fused to, the side of the cannon bone. Occasionally there is also an indication of the upper end of the second metacarpal. But in regard to the upper and lower vestiges of the fifth metacarpal, the interesting new point has been discovered that in the unborn lamb they are continuous. Thus there is in the fœtus or embryo what might be called a complete fifth metacarpal. This is a fine instance of the past living on in the present. A vestige may linger though it has dwindled far below the level of utility.

The Coupling Worm.—A common sight on the farm is the sexual congress of two earthworms, and one might be pardoned for expecting that by 1925 all that was knowable on the subject would be well known. But this is far from being the case, as the discrepant accounts in the text-books plainly show. Some obscure points have been recently elucidated by Mr. A. J. Grove of Sheffield University. Anyone can see that the coupling worms lie half-glued together in a head-to-tail position. But that is only a superficial observation. The intimate union of the couple is partly due to a slimy secretion of skin-glands, and partly to the apposed body-surfaces being mutually penetrated by the bristles, of which there are eight on each ring. The position of the two worms is very precisely adjusted, so that rings 9-11 of X are apposed to the "saddle" (or swollen glandular girdle formed by rings 30-35) of Y, and *vice versa* of course. Ring 15 of X is opposite ring 26 of Y, and *vice versa*,—little adjustments on which depends the mutual fertilisation, or insemination rather, of the two hermaphrodites. For we should have started by saying that every earthworm shows hermaphroditism or a combination of the two sexes and produces

both egg-cells and sperm-cells. In due course there follows a mutual exchange of seminal fluid; but there is some complication, for the sperms of X do not pass into the female duct or oviduct of Y, nor *vice versa*, but in a somewhat complex way they find their way into the sperm-reservoirs or spermathecæ which lie in rings 9-11. In these spermathecæ the spermatozoa are made into packets or spermatophores, and these are, as we have often seen, protruded on the earthworm's skin. When the eggs of X are liberated from ring 14, where the oviducts open, and are carried forwards by a barrel of slime, the spermatophores, made from the spermatozoa of Y, are swept off and carried into the cocoon where the actual fertilisation of the ova occurs. The moving forward of the slime barrel, made by the saddle, is due to the earthworm drawing its body backwards. As the barrel passes over the worm's head the ends close, and this makes the cocoon that one sometimes finds when digging. It includes the egg-cells of X and the sperm-cells of Y, or *vice versa;* and within it from the fertilised ova there develop minute earthworms. We have taken this familiar phenomenon of the coupling worms as an illustration of the complexities that underlie everything. Mr. Grove's investigations have cleared up certain obscure points in an everyday occurrence, and yet we must confess that we cannot even with his aid picture the entire situation with clearness. How, for instance, do the tiny cartridges of spermatozoa come to be protruded so definitely from the sperm-reservoir or spermathecæ, for we see them as tiny tags attached to the skin.

Indictment of the Bracken.—One aspect of the struggle for existence finds vivid illustration in the competition between the vigorous bracken and other plants. It smothers and conquers them all, including the heather. Thus it has been for many years steadily reducing the extent of upland pasturage. This is the first charge against this insurgent fern. In a recent paper by Mr G. F. Scott Elliot, in the Transactions of the Dumfriesshire and Galloway Natural History Society, it is pointed out that when sheep, especially tups, force their way through the bracken, they are sometimes cut on the forehead below the horns. Blow-flies attack the wound, and the sheep may succumb to the attack and die among the fern. This is the second charge. Mr. Scott Elliot goes on to say that the bracken shelters the sheep-tick (*Ixodes ricinus*) which is supposed to be the carrier of the disease called "Trembling." This is the third charge. But we read the other day what we should have known before, that the Forest Fly, *Hippobosca equina*, troublesome in certain places, is dependent on the presence of bracken. It shelters among the fronds and the larvæ are liberated in the decaying humus underneath. This fly attacks horses and cattle, frightening them and sucking blood. Its habits have been recently studied by Mr. Isgaer Roberts. But our point at present is that we have here a fourth indictment of the bracken. Mr. Scott Elliot discusses with great shrewdness what can be done to check the insurgence of the bracken, but his advice comes in the main to this: Cut more bracken and burn less heather. "When bracken is beginning to establish itself, do not burn at all, or very lightly, and only when the ground is

damp." "When the heather has been destroyed by overburning, all the competitors of bracken are killed or arrested in growth, while the rhizomes of bracken some six inches below the soil are quite uninjured." Biologically, this is an interesting study in the struggle for existence; practically it is of great importance.

More Wheels within Wheels.—Earwigs are not usually very troublesome in this country, but they sometimes become a plague, and that has been the case recently in New Zealand. In this connection it is very interesting to hear that already the entomologists at Rothamsted have been rearing huge numbers of two minute insect-enemies of the earwig, and are shipping these to the Antipodes. The insect-enemies behave to the earwig's eggs as familiar Ichneumon-flies do to caterpillars. They pounce on them and lay their own eggs in the earwig's, which obviously means a reduction of the pests. The anti-earwig parasites have parasites that prey upon *them*, for as the old doggerel has it, "Great fleas have little fleas upon their backs to bite 'em." But the Rothamsted nurses have been very successful, and it will be interesting to hear how their charges behave themselves when they are let loose in New Zealand. Will they attend to the earwig business, or will they die of home-sickness, or will they find new enemies that are too strong for them? It will be interesting to hear the result, but the point is that investigators like those at Rothamsted are more given to looking and doing than to waiting and seeing; and that this anti-earwig experiment is on a line with others that have already proved successful in a high degree. This is the biological control of life.

White Blackbirds.—There is a case in the Natural History Museum in South Kensington showing albinos, that is to say, animals born without their natural pigment. Thus there are white blackbirds, white crows, white swifts, white rabbits, white rats, white mice; and, as the last examples show, it is possible to establish a healthy, true-breeding race of these albinos. What happens when an albino suddenly crops up in a pigmented race? In all probability the factors for pigmentation have been lost in the intricate nuclear manœuvres which occur in the ripening germ-cells. Thus in the case of an animal with one of the dark pigments or melanins, it seems to be necessary for a ferment (tyrosinase) to act on a pigment-producing substance (tyrosin); and if either factor should drop out of the inheritance, the fertilised egg-cell would develop into an albino. As is well known, the eyes of true albinos are red, because the blood shines through an unpigmented iris.

Probably quite different from what we have just referred to as "true albinism" is a phenomenon which has been noticed several times, where a coloured animal suffers de-pigmentation. An interesting case has been recently described by P. Murisier. It concerned a hen, three years of age, that changed from black to white and also developed masculine characters. The feathers lost their pigment from the base upwards, and in seven months the hen passed through four stages—uniform black, pied with a white head, white, and finally "isabelline," which we take to mean sand-coloured. The reproductive organs were normal but the

bird seemed to be suffering from pernicious anæmia, and the post-mortem examination also showed that there were great deposits of pigment (hæmosiderin) in the liver. Thus this "false albinism" would differ from "true albinism" in being acquired rather than inborn, in implying de-pigmentation rather than non-pigmentation, and in being pathological.

Guests of a British Tree-Ant.—Just as some plants, like vetches and bryony, are ever ready, during their growing period, to attach themselves by their tendrils to other plants, so some animals have a particular gift in the way of linking other lives to theirs. This is very well known in regard to ants, which may have guests and pets, partners and even slaves. Part of the reason why so many other creatures become linked up with ants may be that the "little people" have a firm foothold in the struggle for existence, being dreaded by many animals. They are thus able to afford some protection to their associates. We are too apt to think of these interesting things as peculiar to warm countries, but this is very far from being true. Mr. Horace Donisthorpe, a distinguished investigator of the ways of ants, has recently studied the associates or "myrmecophiles" of an ant, Acanthomyops or Donnisthorpea brunneus, which has been found on various trees in Buckinghamshire and Windsor Forest. A list is given of no fewer than thirty Myrmecophiles: seventeen beetles, two Hymenoptera, three Diptera, one bug, one green-fly, one spring-tail, one spider, and a wood-louse,—all found associated with this one kind of ant. It is prodigious! The food of this tree-ant consists chiefly of the sweet juice that overflows from the large green-flies or Aphids which are kept as cattle. The Aphids generally have the end of their very long proboscis buried in the wood of the branch, and it is difficult to remove them without breakage. "However large they may be the ants drag and jerk at them unmercifully to make them leave go, so that they can carry them off."

Why are there so many Insects?—We have often asked this question, but we have never been satisfied with the answers that suggest themselves. We have been asking it again lately because of the abundance of insects in the past summer, and also because we notice that Dr. A. D. Imms in his big new Textbook of Entomology puts the number of described species of insects at 450,000, a stupendous total. It exceeds by 200,000 the estimate made by Dr. David Sharp 30 years ago. One reason for the multitudinous variety of insect species must be their small size, for that opens up possibilities of life almost exhaustless. There are, indeed, a few large insects, like the goliath beetle and the Morpho butterflies, but they are exceptional, and there are physiological factors which hinder an insect, breathing as it does by tracheæ or air-tubes which ramify throughout the body, from exceeding a very moderate size.

A second reason is to be found in certain excellences characteristic of insects. Think, for instance, of the perfection of their musculature and respiratory system, of the way in which their movements help their breathing, of the enclosure of the body in a callous non-living cuticle, of the shunting of all the moults into the growing period before there are wings, of the reserves laid up in

larval life which often allow the adult existence to be devoted more or less exclusively to reproduction. Then there is in many cases an extraordinary capacity for prolific multiplication, which again has something to do with the punctuation of the life-history into nutritive and reproductive phases.

Thirdly, from among these excellences we may separate out the power of flight, for this liberated insects at an early date from the risks attendant on purely terrestrial life, and also extended the possibilities of diffusion and of discovering new habitats. Fourth, though we cannot explain it, there is among insects great variability within a relatively short radius, and an associated plasticity, which has enabled insects to make themselves at home in almost every habitat—not excluding the open sea—and to thrive on an unparalleled variety of diets. We could give other reasons, but we would probably still be asking—Why are there so many insects?

More Surface.—Part of the secret of an average insect's great activity is, we are convinced, to be found in the fact that the blood does not become appreciably impure. This is because the blood is always near some branch of the system of air-tubes or tracheæ, which ramify into every hole and corner of the insect's body. In most other animals the blood goes to the air, either on the skin or on the gills, or on the walls of the lungs, but in insects the air goes to the blood. These air-tubes have a very large internal *surface*, and interchange of gases with the blood is thus facilitated. Similarly, though birds' lungs are relatively small they have a very large internal *surface* on which the blood-vessels are spread out. The feathery gills of the lobster have likewise a very large external *surface* on which the blood is exposed to aëration, as on a country with a big coast-line. The absorption of digested food from the small intestine is facilitated by the immense *surface* afforded by the microscopic finger-like processes or villi which line the interior. People who go to live at Johannesburg, about 6000 feet above the sea, often show a great increase in the number of their red blood corpuscles. This is a very useful adaptation, for it means that at an altitude where oxygen is scarcer than usual there is an increase in the *surface* of the oxygen-capturing red blood corpuscles.

If someone should ask what this has to do with agriculture or the farm, he might be answered by asking what advantage there is in breaking up the soil. Whether this is effected by ploughing or clod-crushing, whether the agency be earthworms or frost, is not the result an increase of *surface* in the soil or among the soil fragments, an increase of surface which promotes, to take the simplest issue, the solution of salts, thus affording more food for the roots of plants? Or one might inquire into the significance of the multitudinous leaves of the grasses, which do not get in one another's way, or into the value of cut-up leaves, which thus increase their *surface* for absorbing carbon-dioxide and for receiving those rays of sunlight that pass through the shade of green and promote photo-synthesis, in other words, the making of starch and other still more precious carbon compounds. A large tree in the middle of a field on the farm may be exposing a leaf *surface* of more than an acre. And this is understating the facts, since the essential photo-synthetic process, of building up the organic out of

the inorganic, takes place in the spacious interior of the leaf. For here again the amount of *surface* counts for much, not only because the cell-walls are very important (a difficult line of thought), but because the starch grains may be seen forming within the very minute chlorophyll discs or chlorophyll bodies, which offer an exceedingly large *surface* for absorbing the carbon-dioxide.

The fundamental illustration of what we wish to suggest—the importance of *surface*—is to be found in the colloidal nature of living matter. The colloidal state is one in which a dissolved substance takes the form of very minute particles or droplets, as in an emulsion, and has therefore a very large *surface*, on which reactions, such as those of ferments, may readily occur. The supreme illustration of what we wish to suggest—the importance of *surface*—is to be found in the convolutions of the fore-brain (cerebral hemispheres) in man and in the higher mammals, for these wrinklings enormously increase the surface in which the higher mental processes have their seat. But this must be taken along with the fact that in the racial evolution of backboned animals, as in their individual development, there is an increase in the branching of the nerve-cells or neurones—again more *surface*.

Perhaps a severe critic might say that we are over-emphasising the superficial, but we wish to put forward in all seriousness the thesis that one of the great trends of organic evolution—from the colloidal amœba to the cerebral cortex of man—has been towards more *surface*.

Earthworms and Feathers.—A learned correspondent calls our attention to a field bristling with gulls' feathers, which the earthworms have pulled into the mouths of their burrows. We have often noticed this departure from the earthworm's usual custom of drawing leaves down into their burrows — a very important custom from man's point of view since it has contributed so largely to the formation of vegetable mould. Everyone knows Darwin's demonstration of this. The leaves that are drawn down are useful in two ways—they sometimes make the burrows more comfortable, and they also serve as food, especially when they begin to rot or are partly fermented by the exudation of digestive juice. But what are the earthworms doing with feathers? It is possible that the feathers keep the burrows drier in wet weather, but this does not seem likely. It is possible that they make the burrows more comfortable; but we have often seen sticking out of the burrows hen's feathers far too large to be of any use. There can be no question of nutritive value, so we think the most plausible interpretation is that the earthworms are simply obeying their instinct to draw leaf-like things into their holes. We have seen them take pieces of string. Blind instinct indeed!

Pigeons without Reproductive Organs.—It is somewhat startling to read Professor Oscar Riddle's report on sixteen male pigeons without a discoverable trace of testicular tissue. It is practically certain that this absence of gonads was complete and permanent, not partial or temporary. The probability is that the defect was due to some developmental disturbance. But a noteworthy fact is that the birds in question showed emphatic masculine behaviour—and some other traces of masculinity. This suggests

that sex-characters may depend on something deeply constitutional, deeper even than the gonads and their hormones, namely, on the primary rate and rhythm of metabolism.

Exchanging Gonads.—No one would dream nowadays of denying the profound influence that the hormones of the reproductive organs may exert on the body. But it is possible that the development of the gonads, as ovaries or as testes, with their respective hormones, may depend on some primary difference in the physiological gearing of the parental germ-cells, especially in the ratio between building up and breaking down, between anabolism and katabolism. Steinach transplanted testes from a young male rat into the female, and conversely. The males put on some feminine characters, such as softer fur and more graceful form; they secreted milk and suckled young ones that were given to them. The females, whose ovaries had been replaced by testes, were not so much changed, but they showed a heavier build and coarser fur than is usual for female rats, and they also exhibited some masculine habits. There are many facts of this kind, somewhat horrible to think of, were not the issues at stake so serious. The hormones that pass from the gonads as chemical messengers throughout the body, now exciting, and again inhibiting, are of fundamental importance; but there is no harm in asking if there is not something that controls the controllers.

ECONOMY IN FARM WORKING.

R. J. YOUNG

[*The following article is the substance of an address delivered by Mr. Young, of Australia, at a recent meeting of Scottish Research Workers. While the examples and illustrations used by the author are drawn solely from oversea and English farm practices and do not necessarily apply to Scotland, the article deals with a subject which is of general interest to farmers.*]

IT would appear to me that your farming methods have not kept pace with your technical and scientific advancement. This view impresses me very strongly as I come from a country where I think the opposite criticism should be made—that is, that there the scientific and technical side of agriculture has not kept pace with farming practices. In Australia we are trying to remedy this disparity by technical education, largely by employing skilled men from here and by a willingness to learn from either Europe or America. My criticism chiefly applies to the past fifty or sixty years, during which science has made such strides, and I think a careful study will show that while the scientific side of agriculture has developed tremendously there is comparatively little difference in the practices of to-day and in those of the earlier years, and for the lack of this evolution in farming practices, though excellent and most valuable work has been done in producing higher yielding plants, though science has made available for practical use almost

every ingredient necessary for plant life, though breeders of live stock have produced earlier maturing and more profitable animals, and though science has materially added to the knowledge of their feeding, information is still awaited regarding how to reap the advantages of this research and development by more profitable farming practices.

Few people will controvert the statement that the position of agriculture is not satisfactory, yet one sees very little in the volume of correspondence in the Press of any attempt to analyse the position with the object of arriving at what is really wrong. It cannot be suggested that the trouble is inflated rents, for I think it is recognised that the general rent charge is below an economic basis. It cannot be suggested that the labourer's wage is out of proportion to his necessities. It cannot be suggested that the work is badly done and that the crops produced are low in yield, for they are—year in and year out—among the highest averages in the world. It cannot be suggested that the prices charged to the consumers for their meat, bread, etc., are not as high as they can reasonably be expected to pay. It *can* be suggested, however, that by cheaper transport, by co-operating in marketing, and by a reduction in middlemen's charges a higher share of what the consumer pays could reach the farmer's pocket; but I think that when full allowances are made for the advantages possible from such sources it will still be necessary to look to more economical farming methods as one important factor in really solving the question—and in saying this I want it to be distinctly understood that I am not in any sense underrating the benefits agriculture will still receive from the research work now going on. Neither do I suggest that the work as one sees it now is badly done. But I do ask the questions—Is it economically done? Does the farmer make full use of the capacity for labour of either his man or his horse? I think not.

I should at this stage like to explain why I think the situation has arisen that farming practices here have not kept pace with science, and that overseas technical knowledge has not advanced as far as farm practices. Fifty to sixty years ago Britain's farming methods, as well as its live stock production, led the world, and the farmers of America, Canada, Australia and New Zealand, in fact all English-speaking countries, based their practices on what they learned here. During that period the development of live stock has enabled this country to maintain its supremacy, and all the countries named still look to Great Britain for the highest types of animals with which to improve their flocks and herds; but it is not so with farming practices, for while an abundance of low paid labour permitted cultivation to proceed here with very little change of method, a short supply of much more highly paid labour forced the farmers overseas to devise more economical processes, and as a result of this economical necessity the methods of cultivating and harvesting, though originally the same as here, are now entirely different, and the great difference is in the much higher value received from the labour of their men and horses.

The lack of money and the scarcity of labour resulted in the farmer overseas having to do much of his own work, and as a result

his mind was always bent on the study of means for quickening his labours, and, as a further consequence, he was ready to follow any advantages suggested by his neighbour and thus unconsciously cultivated a disposition to make changes Again, every farm labourer overseas was, and still is, a potential farmer, and consequently was as ready as the farmer to welcome any suggestion that increased the value of his output, recognising that every such advance hastened his own chance of making a start.

One result of the then conditions was a lack of technical knowledge, and a consequent tendency to look to economical farming methods as the chief weapon with which to fight the economic conditions, with the result that there, unlike the position as I see it here, the technical and scientific side of agriculture did not keep pace with farming practices. Though much has been done of later years by agricultural schools and by universities in research work generally, much remains to be done.

I think I am right in saying that it has not been the custom to consider that an important part of the training of those who control agriculture is to go through the workshop of agricultural labour, and if many of those to-day in charge of agricultural work had had as a part of their training to walk over ploughed fields leading or driving a pair of horses in a land roller, or similarly taking a pair in the harrows, the thought would have occurred to them many times while resting at the ends that they could have done their work more expeditiously and comfortably had they been allowed to ride, and would have made a mental note in that regard for the future. Likewise I can imagine them, while putting in overtime in the winter trying to dry and clean the heavy hair on their horses' legs, making another mental note. I doubt if when told off to carry sacks of wheat they would readily have admitted that 252 lbs. was the ideal weight of a sack! In fact throughout their probation, whether it were hoeing turnips, docking corn, or suffering the dust from the thrashing machine, their educated minds would have been constantly devising improvements, many of them possibly impracticable, but a sufficient number of them sound enough. Many of the practices of land labour would to-day be much more interesting and less laborious to the labourer, and consequently more profitable to the farmer. I am sure that the omission of this training in what may be called the drudgery of farming has been a serious omission in the equipment of the otherwise highly technically trained agriculturalist, and one of the chief causes of the slow evolution in farm practices.

Australia owes much to a Scottish Professor of Agriculture who spent many years there, viz., Professor Lowrie, who was trained at the Edinburgh University, and was the first man who introduced scientific ideas into Australia. Were I asked to name the one man who had done the most for agriculture in Australia I would unhesitatingly name him. He later went to New Zealand in charge of an Agricultural College, and I well remember him saying to me when once on a visit to him there, "If a farmer knew how to get work done like a New Zealander, and knew what to do like a British farmer does, he could go to England and make a fortune."

Now how can agricultural work be done more economically?

Certainly not by lower wages, for economy in manual labour is no more obtained by lowering wages than cheapness of horse labour is brought about by under feeding. Neither is the alternative so often suggested, that of laying arable down to grass, economical. They are both stages of retrogression, and progress is not made by advancing backwards. The remedy is not to be found in stagnation but in evolution, and here may I quote from a speech made by the Prime Minister at Welbeck Abbey on 1st June last, when he said:—"We are up against the keenest competition that we have ever been up against, and unless we can sell our goods to meet that competition, we shall not sell them at all. To do that in many ways we shall have to throw aside old methods and practices. Businesses in the same trade will have to come together, they will have to concentrate on modern plant, they will have to scrap the old, and nothing but the using of the best brains among them, and the best endeavours on the part of all concerned, will enable us to pull through these times. For industry has never been static; it was always in a process of evolution."

I know that to many any suggestion of radical changes in practices, and the consequent scrapping of old plant, will be met by the word "impossible," if for no other reason than the financial one, and I quite agree that the financial aspect forbids the individual farmer making costly experiments, and also agree that changes should not be made without proper proof of their advantages. I also realise that many farmers would, after the advantages of changes were fully demonstrated, find it equally impossible to finance themselves over the evolution stage. Consequently I think that the enquiry into the experiments with, and the demonstration of, agricultural practices, should be the work of the agricultural bodies, and I think it may safely be assumed that whatever political party were in power, arrangements would be made to finance the farmer with the initial expenditure resulting from any changes recommended. Nevertheless the governing body will be helpless unless it is supported by the farming community as a whole, and the first step towards getting that co-operation is the cultivation within the mind of the farmer of a disposition to make changes.

In 1837 a paragraph in an Encyclopædia of Agriculture condemned the Kent Plough as obsolete and too heavy of draft. Over 50 years ago trials of ploughs were made by the R.A.S., when the same plough was condemned, and for the same reasons, yet in 1925 one finds that plough without alteration still largely being used. I mention this one example to illustrate how futile it is to suggest changes, and even to demonstrate their advantages, unless men's minds are trained to adopt them.

I do not propose to suggest the form such propaganda should take, but will illustrate my point by quoting two examples from Australia.

In South Australia what was known as an Agricultural Bureau was established, presided over by the Head of the Agricultural Department, and he was supported by an Advisory Committee of well-known farmers. Groups of farmers, often only 10 to 12, were encouraged to form branches. The Head Office kept

these branches supplied with all State publications, and arranged that periodically they should be addressed by experts, and in many other ways endeavoured to keep the interest of the branches sustained. These small branches met and discussed agricultural practices, seasonal difficulties, and at times subjects submitted to them for their judgment by the Central Bureau. It was found that by keeping the branches small the members found it easy to meet, and every member felt himself a unit. I saw this movement grow up, and consider it was a great factor in earning for that State the credit of being the most advanced in agricultural practices.

Much good has been done by systematic experiments conducted on farms. The work was done by the farmer who kept any produce, while all out-of-pocket expenditure and supervision was supplied by the department. These experiments were invariably conducted within view of main roads, with notice boards erected giving the progress and history of the experiments so that farmers passing could draw their own conclusions.

The economy of labour is not governed by the question of the wage the labourer receives so much as by his adaptability and readiness to accept new conditions, and his keenness and interest in his work; by the suitability, or otherwise, of the farm improvements, that is, in the equipment of barns, stables, feed houses, yards, roads, etc., as well as its general layout for convenience of working. It is influenced by the type of machinery used and by the extent to which such machinery permits a man to get the maximum return from his labour. It is influenced by the horses used, by the extent to which they are adaptable to farming practices, and by considering whether their rate of progress is such that the man working them can get again the maximum return from his labour.

I do not propose to deal with the question of farm improvements beyond remarking that much loss is entailed in working costs on many farms that could be economically avoided by the expenditure of capital. Many buildings designed for the class of work prevailing sixty years ago are not adaptable for the working practices of to-day, and I think are often the cause on many farms of the older practices prevailing. I venture to think that the saving in working costs that could be made in the modernising on many farms of their equipments would be materially greater than the interest and depreciation cost resulting from the outlay.

I now come to the question of labour of men and horses, and, as I remarked earlier, the oversea farmer gets a much greater value from both sources than is usual here. Now, is there any, or perhaps I should say, are there sufficient reasons to account for the fact that farming operations in England cost from double to treble the cost of the same operations oversea, notwithstanding that the men performing them are receiving only half or less than half the wages paid? Can the English farmer compete in the growing of corn when his competitor ploughs for 8*s.* and often less per acre, and harrows, drills and cultivates for corresponding charges? Can he continue to be content to thrash 30 to 40 quarters of wheat per day, using ten to twelve men, when the Canadian farmer gets 200

quarters using less men? It is because I ask myself these and similar questions, and because I hear them asked by so many farmers from overseas, that I have studied the question here to see if there are any prohibitive reasons against working costs being brought closer together, and I am fully convinced there are not. A thorough survey of this side of agriculture must, I am confident, discover means of materially reducing working costs, and bring them to a point that will permit full advantage being taken of research work. Until a bushel of wheat can be produced for less than the farmer receives for it, it leaves him cold to be told how to grow more bushels per acre. The survey of the question of working costs should, I think, first begin with a study of your own practices, to see how far a pooling of your own knowledge would take you, and I am sure such a study would make many oversea practices appear more feasible. For is there any greater difference between the New Zealand worker using a four-horse team and, say, the Hampshire worker using a three-horse team, than there is between the Hampshire man driving three horses and, say, the Kent man who is supplied with an assistant to control the same number? Could not the Kent man do what the Hampshire man does? And in turn, could not the Hampshire man do what the New Zealander does? Would not a pooling of your knowledge prove who was nearer right? The many Southern farmers who employ three to four men to drill in 9 acres of corn per day, or the Scotch farmer who employs one man to do the same work? The man who drives his horses tandem in wagons and rollers or the man who works them abreast? The man who works three horses abreast with one driver in the binder, or the man who has one horse leading and an extra attendant? The man who uses a sheaf carrier or the man who does not? The man who employs men to carry the straw in bundles from the thrashing machine up a ladder on to the stack or the man who uses an elevator? I think you will agree with me that a survey such as I suggest would find many such divergencies in practices and that they were not the result of peculiar necessities, but, more like Topsy, they "growed."

With this examination complete, and the local practices tabulated in their order of merit, a second enquiry could follow into oversea practices. It would be found that the men engaged (I am now speaking of Australia) are either men from these Islands or the sons of British born people, and that the horses are almost entirely bred from British stock. A man who was one of three on an English drill may be seen on a combined implement, which cultivates the soil, drills the corn and distributes the manure, and is drawn by six horses—the whole work in his sole care. A second man may be seen driving six to eight horses in a three or four furrow plough, who, before he left England, was rated as capable only of driving a pair in a single furrow plough. A third may be seen driving six horses in the harrows and riding at his work. A fourth using a combined harvester driving six horses and controlling the machine which removes the grain from the straw, thrashes it from the ear, putting it in the sacks ready for market, and in a good crop delivering more wheat in one day than would come from many thrashing plants in two days employing 12 men.

The observation of such farming operations, which, I may say, are the rule and not the exception, will explain why wages there may be higher and yet profitably paid. Does it not also suggest that the farm worker has a much greater capacity than he is credited with here? This observation would also disclose that the operations I have mentioned are not suitable to farming conditions here, the large teams being impracticable and the harvesting methods impossible, but would they not suggest an economic point between the pair horse team and the eight horse team, and between the 30 to 40 quarters of grain thrashed here and the 200 quarters in Canada and America, although the actual systems are not applicable?

One thing definitely proved overseas is that, given the tools to work with, the farm worker can rise to the occasion. I admit the fact that the farm worker overseas feels that he is qualifying to become a farmer is a factor of considerable importance, and may I again quote Mr. Baldwin when he said:—"Technical efficiency is not enough; no management is scientific which forgets the man inside the workman."

Though the farm worker here cannot have the same opportunities, cannot more be done in providing some opportunities for rising and starting on his own? Cannot his work be made more interesting, and drudgery largely eliminated? We have to remember that owing to general education men's minds are trained to think more than when they lacked education, with the result that the keener the intellect becomes the less can a man adapt himself to work lacking in interest. Consequently, with no diminution in the drudgery of farm work the farm labourer becomes of less value because of his increased education instead of, as it should be, of greater value; and farming practices are not keeping pace with the changes in the mentality of the worker.

An enquiry into the question of horse labour would, I think, disclose as a general rule that a pair of horses in England will plough three-quarters of an acre per day, and in doing so will walk a little over 8 miles in the process. In Australia it would be found that they would walk from 14 to 16 miles per day in fairly heavy work and 20 miles per day in lighter work, such as drilling, etc. I have naturally looked for explanations, but have only found the more frequent turnings and a shorter working time in the field to account for a portion of this difference in results. However, I would have no hesitation in placing the pace of the horses as the chief contributing factor. For there is no doubt that the pace is much slower than should be, and in making comparison I would attribute it to two causes but would find it difficult to divide the responsibility.

The two causes are—first, with the animal itself, and secondly, because the driver walks while with his team, and consequently is inclined to check them and bring them back to his walking pace. The majority of farm horses in England are much heavier, and being much fatter are proportionately still heavier, naturally slower and less able to stand the heavy walking without tiring than the Australian farm horse, which, with the exception of a limited number bred or descended from imported English draught

mares, have all more or less a strain of the thorough-bred in them. My experience during many years with farm horses, when I was controlling from 200 to 300, satisfied me that the heavy horse could not do the same amount of work as the thick set, lighter sort that has almost become quite a type with us, and to-day I am more convinced than ever that the heavy horse is not a farm horse. Your cattle and sheep are recognised the world over as the best, but not your horses in America, either North and South, that is by the farmer, who chiefly uses the percheron—a breed of horses bred from working strains. It would appear to me that the question of breeding a suitable farm horse has never been studied in the same way as that of breeding of other animals. That is, they are not bred from results. A race horse is bred from a sire and dam that have proved their ability to gallop and can thus be expected to produce a galloper. Hunters from stock that first prove their ability to jump. The dairy cow is bred from stock that has to stand a rigid milking test. The beef animal from stock that show the necessary merits in their conformation and their ability to mature early. Even the hen comes from yards possessing proved laying strains, and so on. The farm horse is not bred from stock that has been proved to possess the qualities necessary for the work they have to do. They are not judged on their capability of walking 20 miles over ploughed land each day for six days a week and hauling their proper load, but more on show points such as colour, markings, and size and conformation, with the consequence that the more fashionable a strain of blood becomes, the further back one has to go in using one of the sires to trace back to the time his ancestors worked. Is there no way a type of farm horse can be bred from working stock with proved records? On the question of farm horses carrying such an abnormal amount of fat, it is interesting to note that with working bullocks, which probably of all draught animals, except perhaps the camel and donkey, has to suffer most privations, the least satisfactory are shorthorns, and in fact all the best beef producing breeds, and the most capable and fastest travellers, are obtained from milking strains that have the least tendency to run to fat. Surely a lesson can be learned from this.

In dealing with the question of speed at work, the driver either leading or driving his horses and walking himself will always prevent the full mileage being obtainable, even at good walking pace, and entirely bars the use of horses at any faster pace, which many times would otherwise be possible if provision were made to allow the man to ride. I place most stress on this, and would see little hope of increased speed as long as this system prevails.

There is much work done on a farm by the "all works" man, who usually has one of the slower horses on the farm, which could with great advantage be replaced by a light, active horse in a spring cart capable of carrying half a ton, but with which when empty or more lightly loaded the horse could travel at least 6 miles per hour. This aspect of the farm men never riding would explain to me why farm horses are never seen moving beyond a walk, although often on the same roads one may see a town lorry, perhaps delivering coal or some such load, and trotting comfortably

as long as the road is good. I feel that I am far from alone in realising the unsuitability of the general farm horse from the point of view of efficiency, for how many farmers, dissatisfied with their day's work, have turned or are turning towards the use of the tractor in the hope of getting their work done in a more reasonable time, and there is no doubt much advantage is to be gained by the introduction of the tractor, but I think it may safely be assumed that however valuable an adjunct that is, and undoubtedly it is, much farm work will always be done with horse traction—and the use of the tractor itself will in all probability by comparison in pace help to bring about a general speeding up of horse work.

I am afraid my remarks are rather disjointed, but I hope I have made myself clear. I have been farming for many years, and at least long enough to know that because we can do certain things in Australia you cannot necessarily do it here, and I have not quoted work done in Australia with that idea, but rather to show that if changes are found necessary both men and horses can be made to adapt themselves, and that such changes are not necessarily made by copying others but by evolving them to suit your own peculiar conditions—but also that many changes are necessary. The higher standard of living expected by workmen, and which no farmer wishes to reduce, makes the economic use of one man to two horses as worked to-day an impossibility. On much land in England and possibly in Scotland much ploughing and cultivating can be as easily done by four and five horse teams as in Australia. My own experience here with a five horse team has been that I could plough 3 acres per day to a depth of 4½ inches.

THE MILK INDUSTRY OF AMERICA:

SOME OBSERVATIONS.

RENWICK HUTSON LEITCH, M.A., B.Sc. (Agr.), B.Sc., N.D.A. (Hons.), N.D.D.

PART II.

PASTEURISATION OF MILK AND ITS CONTROL.

AMERICA prides itself on its pasteurised milk, and a few details of the regulations regarding the handling of this product may be of interest.

(*a*) Only milk pasteurised by the holding method may be sold to the consumer.

(*b*) The temperature of pasteurisation required by City Ordinances is 142° to 145°F. for 30 minutes, with immediate cooling to a temperature below 50°F.

(*c*) The pasteurising equipment must be of a type approved of by the Board of Health. In order that the Bureau of Food Inspection may be assured that proper pasteurisation is being

accomplished, it is required that a recording thermometer be attached to each pasteurising machine, the chart of which shows the time of starting, the duration and the end of the process, and the temperature record. In Toronto these self-registering thermometers are actually owned and controlled by the Department of Health; the case in which they are carried can be locked, and the Department keeps the key. The daily records of these plants are required to be sent to the Board of Health once a week. On this record are noted in addition the type of machine, the quantity of milk treated and the method by which (or the place where) the mercury bulb of the thermometer is attached to the machine.

(*d*) Pasteurised milk must be labelled (on the cap of the bottle or on the bulk container) "Pasteurised Milk," together with the day of the week on which the milk has been pasteurised and the address of the pasteurising plant.

(*e*) Bottling immediately after pasteurisation is requisite.

(*f*) Milk shall not be pasteurised more than once, and must be delivered to the consumer not more than 24 hours after the time of pasteurisation.

Control of pasteurisation is regarded as one of the most important duties of the Department of Health and strict attention is given to this work. To have one inspector constantly in attendance at each pasteurising plant during its entire operation is obviously impossible, and generally speaking a weekly visit to each plant is all that can be accomplished in large cities like Chicago and New York. The following plan is in operation in Chicago. In addition to the routine visits paid by the inspector, surprise and check tests are periodically made. In this case the inspector is [illegible]sent throughout the whole operation of pasteurisation, an[illegible] an official record or chart of the complete day's run. Th[illegible]cimen chart," as it is called, is used to check the acc[illegible]uracy [illegible]ubsequent charts sent in from the plant. Where [illegible]he latter [illegible]icient or vary from the "specimen chart" (as seen by the insp[illegible]during the actual operation) the discrepancy must be explaine[illegible]e inspector or to the chief of the Bureau.

Note tha[illegible]e record charts show the temperature of pasteurisation, t[illegible]e of holding, the time of beginning, and the time of ending of [illegible]rocess. An examination of these charts makes it possible to d[illegible] such practices as follows:—

(*a*) Add[illegible] of skim milk, cooler than the batch, which has been a[illegible] to the hot milk at the end of the pasteurisation period.

(*b*) Falsi[illegible]charts, that is to say, charts made by the hand, i.e. hea[illegible] the milk to 145° momentarily and moving the chart by [illegible]d; such a chart shows a perfectly straight line of holding[illegible]e.

(*c*) Insuffici[illegible]holding period, one or more batches being held less than t[illegible]quisite period of 30 minutes. (Each space of the chart repr[illegible]ts 15 minutes.)

(*d*) Uneven t[illegible]atures or improper heating.

Bacterial Standards for Pasteurised Milk.—The bacterial standards for pasteurised milk vary in different cities, but generally they are lower than that allowed by the Ministry of Health in Britain. Some cities also impose a limit on the number of bacteria in raw milk intended for pasteurisation. The following are representative standards for cities in the States.

	Raw Milk before Pasteurisation.	*Pasteurised Milk.*
New York—Grade A	200,000	30,000
Grade B	1,500,000	100,000
Chicago (May to Sept.)	1,000,000	100,000
(Oct. to April)	750,000	50,000
Detroit	—	100,000
Omaha	1,000,000	150,000
St. Paul	2,000,000	50,000
Toronto	—	100,000

In America the Departments of Health in the large cities periodically communicate to the press or publish in an official leaflet a list of the dairies which are rated by them as "First Class."

TRANSPORTATION OF MILK.

Both in Canada and in the States a very large volume of the milk consumed in the cities is transported by road; and this method of transportation is on the increase. The following figures give some relative idea of the extent of the road traffic in milk. In Baltimore, 45 per cent. of the city milk supply arrives by motor truck; in Philadelphia 20 per cent; in Cincinnatti 97 per cent.; Detroit 88 per cent.; Milwaukee 77 per cer St. Paul's 94 per cent.; and Indianapolis 94 per cent. If mil' sent direct from the farm to the town, it generally arrives in s by motor wagon, but if sent from country collecting stats it is mo re frequently transported in truck tanks. Praclly all City Ordinances require that milk sent in cans by ror wagons be sufficiently protected against extreme weatheonditions and especially against high temperatures. Protectionafforded either by a canvas frame-work over the motor body r by a canvas covering over the individual cans.

The use of truck tanks for transporting milky road is increasing in favour; about 80 per cent. of Detroit'nilk supply is so shipped. (In Chicago, on the other hand, on about 4 per cent. of the city milk supply is transported in truclanks.) In Detroit one milk company alone (The Detroit Creatry Co.) employs a fleet of forty truck tanks to bring the milfrom the collecting stations in the country to the town, the average haul being 40 miles.

These truck tanks are cylindrical steel cinders made of heavy plate steel, seamless and lined internally th blue glass enamel which is fused to the steel at a high tperature. This glass lining does not chip or crack. The tars are mounted on the chassis of any standard motor truck, resig on pads and held in

place by steel bands. Each tank is fitted with a swivel manhole through which the milk is charged and by which cleaning is made possible. An air inlet and a large discharge tap are accessory fittings. For long distance transport, these truck tanks may be insulated. The low temperature to which the milk is chilled before transportation (40°F.) obviates the risk of any churning taking place during transit. Even over a long haul and in hot summer weather little rise in temperature takes place; seldom is the rise more than 2°F.; railway churns under the same conditions would probably show an increase of 8° to 10°F. These tanks on arrival at the depots are emptied by means of sanitary piping, which allows the milk to flow by gravity from the tanks to the receiving vats; but when, as is often the case, the milk is sent direct to the storage tank situated on the upper floor of the depot, air pressure is employed to empty them and at the same time to elevate the milk. The employment of air pressure is superior to pumping because it obviates foaming of the milk.

On account of the road laws, the maximum capacity of these tanks is usually limited to 1000 gallons, though truck tanks with an accommodation of 1500 gallons are on the market.

The advantages of the truck tank are (*a*) labour and time is saved in cleaning and sterilising; (*b*) at the end of the journey the milk arrives in better condition than in cans because of the low even temperature during transit; (*c*) spilling is eliminated; (*d*) there is less handling, one tank taking the place of 100 ten-gallon cans; (*e*) the depreciation is low; with care a truck tank will last from ten to twenty years, while the lifetime of a railway churn seldom exceeds four years; (*f*) the truck tank constitutes a good advertising medium: the cyclinders are enamelled white, and against this background the name of the firm and the quality of the milk are inscribed in conspicuous letters.

Railway companies cater well for the milk trade and refrigerator cars are invariably used for shipping railway milk to the city. Shipments of less than a car load are iced by the railway company, the icing of the milk being included in the freight charges. But dealers sending full car loads have to do the icing themselves. The freight charges in this case are relatively lower, the difference due to icing varying from 16 to 30 dollars per car.

The most recent development in the transportation of railway milk, however, is seen in the employment of special railroad car tanks. As in the case of the road truck tanks, the milk containers are large, insulated, one piece, glass-lined steel cylinders, two of which are mounted on a single railroad truck. The truck with the cylinders in position is housed in by a rectangular steel frame work. Within the car itself an internal brine circulation maintains a cold storage temperature during transit. Each cylinder has a capacity of 6000 gallons, so that one of these special railway cars carries 12,000 gallons of milk. Each cylinder is fitted with a manhole for cleaning, a motor driven agitator for equalising the milk fat prior to the discharge of the milk at the end of the journey, a milk gauge, an angle stemmed recording thermometer, an air inlet and an outlet for emptying the tank. Milk, previously chilled at the country collecting plants, is filled into these car tanks

and on arrival at the town depot is emptied by air pressure. It requires three-quarters of an hour to empty each car tank.

This is reckoned to be the cheapest method of transporting milk in bulk. The Bowman Dairy Company in Chicago has now in use 12 of these car tanks in which they ship most of their milk from the country collecting plants, and as a regular traffic is guaranteed to the railway company, special concessions are obtained in regard to the time of despatch and quick transit.

The Weiland Dairy Company in Chicago uses these car containers not only to transport the milk to their pasteurising plant, but also to hold the milk in storage before pasteurisation. Even over a haul of 75 miles by rail these car tanks still represent the cheapest mode of shipping milk in volume, and for large cities this is likely to be the system of the future. The great advantage of these glass-lined tanks from a sanitary point of view lies in the fact that they can be easily and thoroughly cleaned, and that after cleaning they can be sterilised by steam under pressure.

Bottling of Milk.

With the exception of milk sold in bulk to restaurants, hotels and bakeries, all milk must be delivered in sealed bottles. No loose milk may be sold in cans or dippers.

Bottling is not allowed on delivery wagons. The selling of loose milk (i.e. from cans and wagons) so common in this country is regarded as an anachronism in America, and milk dealers there ask when we are going to wake up!

Practically all bottling of milk is done by machinery; hand capping of the milk bottles even in small plants is almost eliminated. Experience has shown that even when it is allowed hand capping must be carefully supervised, as attendants who cap the exposed milk in the bottles may be infected with some communicable disease. A survey of 42 milk bottling establishments in Chicago showed that among the attendants there were two operators giving a positive diphtheria reaction and two with a hæmolytic streptococcus reaction.

Treatment of Milk Bottles.—In this country it is required that bottles in which Certified and Grade A. milk is sold must, previous to being filled, be sterilised by steam. In America steam sterilisation of milk bottles is not practised at all, the necessary sterilisation being effected by the employment of hot alkali solutions followed by a brushing with hot water and a subsequent rinsing with increasingly cold water. Occasionally chlorinated water, i.e. water which has been injected with liquid chlorine, is employed in the final rinse. This treatment leaves the bottles quite cold and ready for immediate filling. The temperatures and strengths of the alkali solutions and the degree of heat in the rinsing waters employed in a large bottle washing plant in New York are as follows :—

Type of Bottle Washer—Yundt 2 unit machine.

(a) *Alkali Treatment.*—(Bottles pass first through the

cleansing solutions or "soaker units" contained in three successive tanks.)

	Temperature.	Time of Immersion.
1st Tank, 6 per cent. NaOH ...	115° F.	3 mins.
2nd „ 5 „ „ ...	140° F.	10 „
3rd „ 5 „ Na_3PO_4 ...	140° F.	3 „

(b) *Water "Brush."*

1st brush with water under pressure	130°F.
2nd brush do. do.	160°F.
3rd brush with air water brush (80-90 lbs. pressure),	190°F.

(c) *Cooling Units.*

(*a*) Aerated water at 135°F.

(*b*) Seven successive water brushes, temperature of each succeeding brush being 10° below previous, the final temperature of the bottle being 60°F.

In Section B. the outside of the bottles are brushed with stiff fibre brushes.

The use of chemicals in the washing and sterilisation of milk bottles, though of recent adoption, is now practically universal in all large milk plants. But it was only after the most careful enquiry that the use of these sterilising agents received the sanction of the Public Health Department. Previous to 1921 the Chicago Ordinance provided that all cans and other receptacles in which milk was kept had to be sterilised with boiling water or live steam. The breakage of bottles consequent on this method of sterilisation was a serious handicap to milk dealers, and application was made for authority to use alkali bottle washers, which in pre-prohibition days were used in breweries. Consequently the Commissioner of Health for Chicago appointed a committee of expert bacteriologists and pathologists to report on their suitability from a public health point of view. Actual tests of the cleaned and sterilised bottles having proved satisfactory from a sanitary point of view, the use of these machines was sanctioned by the Commissioner, and since then other cities have followed suit. It is interesting to note the recommendations of this body of experts on the operation of alkali washing machines.

1. *Machine Alkali.*

(*a*) Minimum proportion of caustic alkali to soda ash 2 to 1.

(*b*) Use minimum charge of 125 lbs. (1·5 lbs. per cub. ft. water).

(*c*) Make solution 12 hours before use, to allow mixing.

(*d*) Minimum alkali calculated as NaOH, always to equal, or exceed, one per cent. (10 grams per litre).

(*e*) Clean machine out thoroughly at least once each week.

2. *Wash and Rinse Water.*

(*a*) Water supply must be safe.

(*b*) Water must have sufficient pressure to effect complete rinsing. No alkali to be left in bottles.

(*c*) Spiral rinsing stream suggested for last two rinsings as more effective than direct stream.

(*d*) Abolish return flow chlorine tank.

3. *Machine.*

(*a*) Minimum temperature always to be at least 120 degrees, automatic thermo-regulator suggested.

(*b*) Maximum speed to expose bottles *within* the caustic soda solution at least 10 minutes.

(*c*) Outside centering device for bottles suggested. Cap seats can be scrubbed with this device.

(*d*) Examine each brush three times daily. Keep brushes over night, or when not in use, in moderately strong soda solution.

(*e*) Be certain that the caustic solution is not diluted by leakage or seepage.

In order to render the water supply safe for rinsing purposes, the Public Health Department in Chicago makes no active objection to the injection of the water supply with liquid chlorine at the rate of four parts per million.

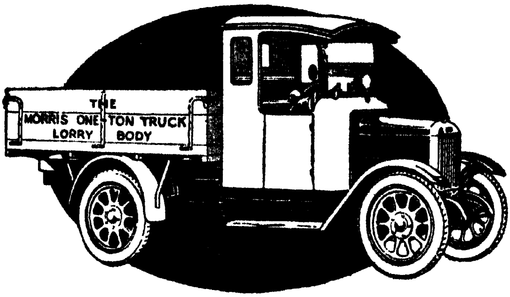
Standardisation of Milk Bottles. — Following on the satisfactory results obtained from the standardisation of all piping and fittings used in connection with pasteurisers, coolers, etc., various associations of milk dealers in America have adopted standardisation in regard to milk bottles, with reference to size, capacity, diameter and form of the mouth opening, and the size of caps. The advantages of adopting standard milk bottles are obvious, but the main advantage gained will be the interchangeability of bottles and the consequent standardisation of all milk bottling and capping machines. It will also serve to perfect the manufacture of milk bottles by different makers, and ultimately to lower the cost of production.

TUBERCULOSIS AND OTHER COMMUNICABLE DISEASES IN RELATION TO THE MILK SUPPLY.

Because of the presence of tuberculosis in dairy herds and of the possibility of transmitting this disease through the milk supply, the Public Health Authorities in America have always been firm believers in pasteurisation. With the full realisation of the extent to which other communicable diseases like typhoid, diphtheria, scarlet fever and septic sore throat illness could be, and actually were, carried by the milk supply, the demand for pasteurisation became insistent, and pasteurisation from being optional to the milk dealer became obligatory to him. In America at the present time all milk except Grade A. raw milk from accredited herds and Certified milk must be pasteurised. The enforcement of this compulsory scheme of pasteurisation was effected in the teeth of very considerable opposition. All the old familiar arguments against

THE MORRIS ONE-TON TRUCK

With LORRY BODY.



Price complete with Lucas Lighting Set, Full Chassis Equipment, and Detachable-sided Body as Illustrated

£225.

Standard Van, £235.

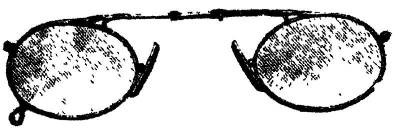
This is a General Service Vehicle, capable of withstanding the roughest usage, and it does its work at the lowest practical cost. Petrol consumption is over 20 miles per gallon.

For Fuller Particulars Consult:—

WESTFIELD AUTOCAR Co., Ltd.,

WESTFIELD AVENUE, GORGIE, EDINBURGH.

Phone: CENTRAL 5420. Telegrams: MORSERVICE, EDINBURGH.



GEO. PRESCOTT & CO.

CONSULTING OPTICIANS.

Principal: J. H. MURRAY. **Telephone:** 1478 Central.

—:o:—

All our lens grinding and assembling is done in Edinburgh under the direct supervision of our refractionists—and particular attention is given to the aesthetic value of the glasses prescribed.

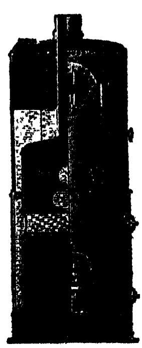
—:o:—

98 LOTHIAN ROAD,

EDINBURGH.

VERTICAL BOILERS

suitable for



STEAMING and STERILIZING PURPOSES ON DAIRY FARMS, etc.

80 lbs. PRESSURE.

4′ 0″ High × 2′ 0″ Dia. to 11′ 0″ High × 4′ 0″ Dia.

From Stock.

COMPLETE PLANTS SUPPLIED and ERECTED.

Send your enquiries to—

A. MURRAY WILSON & CO.,

ENGINEERS,

170 Hope Street, GLASGOW.

the heat treatment of milk, such as impaired digestibility and diminished nutritive value, were adduced, but were proved to be without substance in the case of milk effectively pasteurised to a temperature of 142°F. to 145°F. and held for 30 minutes before subsequent cooling.

Everyone of course agrees that a pure raw milk of the certified standard, if it could be freely and universally obtained, would be the ideal milk for the consumer. But years of experience in America, where certified milk was first commercially produced, have shown that under existing conditions this article can only be produced at a cost which places it beyond the reach of all save the few. A universal certified milk is an ideal which cannot possibly be realised for many years to come. If then we cannot offer a safe supply of raw milk at a reasonable cost, and if pasteurisation is an effective safeguard in the case of our present milk supply, the arguments against a controlled system of pasteurisation altogether fail. The effect of pasteurisation in relation to public health is reflected in the following figures, which are taken from official sources:—

Chicago Death-Rate per 100,000 *population before and after the enforcement of universal pasteurisation of the City Milk Supply.*

	Year 1914.	*Year* 1923.
Typhoid	6·9	1·9
Infant mortality (under 1 year) .	28·5	16·9
Tuberculosis (other than pulmonary)	15·4	9·8
Deaths from all causes (per 1000 pop.)	13·93	11·70

In reference to the following vital statistics of New York, it should be observed that the decline in the death-rate from the various causes cited is correlated both to the supervision of the milk supply and to systematic pasteurisation. In 1906 a preliminary survey in the country of the farms supplying New York was begun with a view to the elimination of the undesirable producer. In 1908 this country inspection was made more effective; in 1912 a scheme of partial pasteurisation was introduced; in 1914 pasteurisation was made compulsory except in the case of Grade A. raw milk.

	1907.	1909.	1913	1915.	1923.
Population . . .	4,314,237	4,632,078	5,048,827	5,224,585	5,927,617
General Death-Rate .	18·36	16·00	16·64	14·58	11·22
Death-Rate (under 5 years). . . .	5·98	5·29	4·10	3·88	2·00
Typhoid . . .	·17	·12	·07	·06	·02
Diarrhœa (under 5 years) rate on whole population	1·53	1·16	·73	·75	·26
Deaths under 1 year .	160	137	102	98	66.
Cerebro Spinal Meningitis	·15	·07	·04	·02	·01
Tuberculosis (other than pulmonary) . .	·29	·27	·28	·27	·12

But while convinced that pasteurisation will render a milk supply safe by destroying common pathogenic bacteria, the American Public Health Authorities are not content to rely on pasteurisation as the only safeguard. The ultimate aim is to exclude all milk coming from tubercular or diseased cows. Indeed at the present time some cities refuse to admit milk which is known to be the produce of tubercular herds, even if the milk is to be subsequently pasteurised. In 1922 the City of Chicago Public Health Department excluded the milk supply of certain farms on which reacters were known to be present. In these cases a considerable portion of the cows were the rejects of herds which had been tuberculin tested under the official scheme of the U.S. Department of Agriculture. The Chicago Health Authorities considered that they would be grossly remiss in their duties if they neglected to guard against the products of known tubercular animals.

Accredited Herd System.

Within recent years the development of the accredited herd system has made rapid progress in America, and it is estimated by some authorities that if the present scheme for the eradication of tuberculosis is vigorously conducted and if the rate of progress hitherto realised is maintained, this disease will practically have been eliminated from large sections of the States in the next twelve to fifteen years. It may also be observed that while the movement for systematic eradication of tuberculosis started with the farming community, the cities are now forcing the pace more than the States themselves. In most sections of the United States of America the Federal Scheme is in operation, that is to say, the Federal Government supervises and controls the testing of the cows, and pays part of the compensation for the slaughter of condemned animals. The scheme operates by counties rather than by limited areas or by individual farms. If 51 per cent. of the farmers in any section demand the application of the Federal Scheme, it is put into operation forthwith. There is no fixed scale of compensation for the slaughter of condemned animals. The sum allowed is generally fixed by an Appraisal Board which is locally elected, and the scale of compensation is commonly based on the market price of the animals. Three parties contribute equally to the compensation fund; (*a*) the Federal Government; (*b*) the farmer; and (*c*) the State. Each party contributes one third.

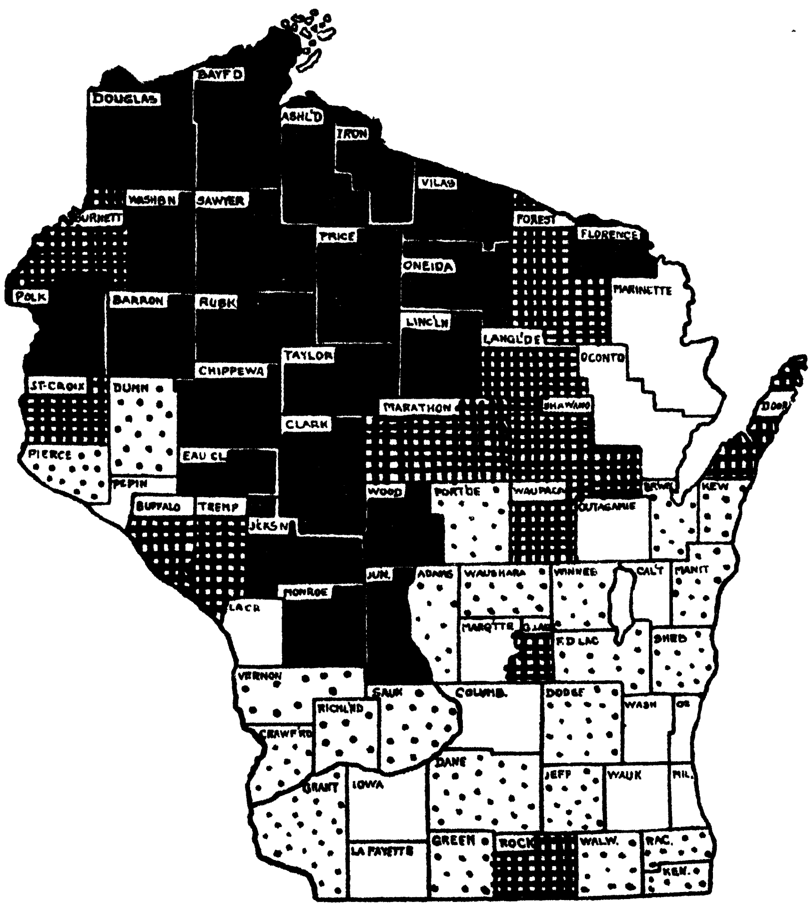
Already a large number of areas have been cleaned up through the operation of this scheme. The attached chart shows the progress made in eliminating tuberculosis from the dairy herds of Wisconsin. It is worthy of note, however, that the percentage of tubercular cows in America is much lower than in Britain. It may also be of interest to note that the meat packers in Chicago pay 10 cents per 100 lbs. more for hogs which come from tubercular free areas than those which come from infected regions.

In passing it may be mentioned that American veterinarians have little faith in Calmette's attenuated vaccine for immunising dairy stock against tuberculosis.

When tuberculosis has finally been brought under control the

BOVINE TUBERCULOSIS ERADICATION IN WISCONSIN.

AREA TESTING PLAN.



Black—All cattle in county have been tested.
Checkered—Petitions signed and ready for test.
Dotted—Petitions being circulated, or considering area test.

losses to the dairy industry through the incidence of this disease will be small, and the profits of the dairy farmer, because of the diminished death-rate, will be higher. In Britain the death-rate from tuberculosis in dairy stock is often so high as to make dairying a precarious business.

Dairy Research Work in America.

Among scientists it is an accepted fact that America has been a leader in Dairy Research for the past three decades. Much of the fundamental knowledge of milk and its products is based on the painstaking and very complete researches of American chemists and bacteriologists. Research work has been largely stimulated and encouraged by Government support; it is sedulously fostered at all State Universities, in whose curricula dairy science is regarded as important as medical or engineering science.

It is not too much to say that the great development of farm and industrial dairying in America owes its success to the fundamental work of the research scientists in Animal Husbandry, in Dairy Chemistry and in Dairy Bacteriology. Both in the United States and in Canada one had continual evidence of the esteem in which the large milk companies and the manufacturers of dairy products held the research workers in the State Colleges and in the Universities.

The research work in Animal Husbandry is impressive both in its amount and in its quality. In America there is greater scope for work of this kind than in Britain because of differences in climatic conditions, the greater number of dairy cattle used for milk production, the number of different breeds employed, and in general the low average production per cow. In the United States of America only 3 per cent. of the dairy cattle are pure bred: the rest are grades and scrubs; hence breeding investigations in the States are of the utmost value. As illustrative of the value of advanced registry work it may be stated that the average production of pure bred high grade cows is three times that of the whole American average.

At the stations in Canada investigations in animal husbandry relate principally to the more general problems of feeding, breeding and management of dairy stock. The application and development of established principles rather than the elaboration of new ideas or of independent lines of research were the characteristic features. In the States the position is slightly different; here there is a greater demand for advanced information and the stimulus towards continued improvement is, if anything, greater. Research work of a high order in the fundamental problems of feeding and nutrition is being conducted by men of world-wide reputation. At nearly all the stations in U.S.A. intensive breeding for production experiments is in progress, and some remarkably good results have been obtained.

The methods pursued by American investigators are familiar to our own research workers, but their equipment and buildings are generally superior to ours. Research work in animal husbandry is always expensive, and skilled assistants are not sufficiently re-

munerated in Britain. In America the Colleges are not hampered, either through lack of money or trained assistance. A noteworthy feature of the research work at the Universities and Agricultural Stations is the co-operation between workers on different aspects of the same problem. Generally before a new problem is tackled, the scheme of experiment is discussed and co-ordinated by the departmental chiefs of the same Station. Such station team work has invariably produced excellent results.

The investigational work in milk and dairy products covers a wider range than similar work in Britain because of the more extended use of milk and milk products. Thus a large amount of research work is devoted to ice cream, to condensed milk, and to dried milk. Butter and cheese also receive special attention. The bacteriology of milk is intensively studied, and some of the best research work in applied dairying has been done in this department. Of special note is the work of Breed and his associates at the New York Agricultural Experiment Station; of Hastings and Frost at Wisconsin; of Macey at Minnesota; of Buchanan, Levine and Hammer at Iowa; of Prucha at Illinois; of Sherman and Hall at Cornell; of the Station workers at the U.S. Dept. of Agriculture, Washington; and of Dr. Rettger. Bacteriological technique is highly developed, and personal inspection of the work being done shows every evidence of careful and painstaking investigation. Some of the features of American dairy bacteriology which attract attention are the extended use of physical instruments and electrical appliances in the bacteriological laboratories; the use and development of specialised and selective media; the standardisation of bacteriological stains; the systematic study and classification of bacterial groups; the specialised isolation methods used in the study of pure cultures of organisms; the intensive study of nusible and pathogenic bacteria in milk and dairy products; the application of special ferments to butter and to cheesemaking; the study of milk beverages; the study of water bacteria and of sewage ferments in so far as they concern the dairy industry.

Reviewing the specialised work on dairy bacteriology, one might venture to say, that while more impressive results have been obtained in milk and its preparations than in Britain, our technical research work in cheese and to some extent in butter in this country will compare favourably with similar work in America. On the other hand, on account of the adaptability of the American nation, the results of research work in dairying have been adopted and have been applied with greater success industrially in America than in Britain.

Teaching and Research Work.—A close association is maintained between teaching and research work. Except at the Government Stations and at the New York Agricultural Experiment Station, the foremost research workers are also teachers, and indeed one of the highest qualifications in a Professor is his ability to conduct research work. It is true that much of this research work is of an applied nature, but the essence of progress in dairying is the application of research to the industry, and it has been found from experience that the best methods of disseminating the

results of research work is through the medium of students who are taught by the research workers themselves. But a strict balance is maintained between the time required for teaching and the much greater time required for carrying out research.

NATIONAL DAIRY COUNCIL.

A review, however brief, of American Dairying would be incomplete without some reference to the work of the National Dairy Council. The services which this organisation has rendered to the dairying industry of America are universally acknowledged and acclaimed. Indeed it is admitted to be the greatest single factor which has led to an increased use of milk and dairy products in America. Through its efforts the consumption of milk has in three years been increased from 42 to 54 gallons per head per annum, and the consumption of butter from 14 to 17 lbs.

The organisation of the National Dairy Council is so well known by reason of its numerous publications that only a few of the more salient facts relating to its operations and activities are set forth here.

The National Dairy Council is operated entirely by voluntary contributions. Its revenue is derived from various branches of the dairy industry,—from milk producers, from milk dealers, from manufacturers of butter and cheese, and from makers of dairy machinery and dairy appliances. The levy on producers and dealers is 1 cent per 100 lbs. milk: last year the return from this source was 400,000 dollars. The amount contributed by machinery manufacturers in 1923 was 40,000 dollars.

The headquarters of the National Dairy Council are located in Chicago, and from here are operated the 12 constituent regional units. Each of these branches has its own staff and equipment complete, and performs the work of the National Dairy Council in the territory which it serves. It collects funds from milk producers and dealers, and carries out all local propaganda and educational work in milk and dairy products. Part of the money raised is allocated to headquarters for overhead national expenses, but most of it is spent on local services.

The closest co-operation is maintained between headquarters and the branch organisations. A conference is held four times a year at headquarters to which are summoned the chief officers of the regional units. Programmes, materials and methods of work are fully discussed by the Departmental chiefs, and the projects in their final form are issued from headquarters. In this way the central Authority benefits by the experience of all local workers.

Perhaps the most important service performed by the National Dairy Council is the educational work on the value of milk and milk products which it carries out in the Primary and in the High Schools. Within recent years the National Bureau of Education has made instruction in health a part of the general school curriculum. This has provided an opportunity of stressing the value of milk in health lessons in school.

The National Dairy Council has framed and issues an illustrated leaflet which has been adopted for use in all schools; in this

publication the observance of eight health rules are advocated, milk and dairy products being the keystone. It is shown that better results are got from these foods when the other health rules are observed. One quart of milk a day for each child is held to be advisable.

Among the many other pieces of literature which the National Dairy Council supplies to schools is a Health Book to be coloured by children. There has been a large and insistent demand for this booklet, and at present from 300 to 400 copies are being posted from headquarters daily. It is stated that in the current year no less than 400,000 copies will be distributed.

In the year 1923, the number of school teachers in the States in receipt of the publications of the National Dairy Council was 100,000, and the number of pieces of literature and material supplied to schools was six million. In addition, there were issued for health talks to children a large number of lantern slides.

Perhaps the most interesting productions of the National Dairy Council are the Health Plays which are performed in the schools. Children are trained to take part in these plays, which emphasise the important function of milk and dairy products in building up the health of the nation. The children who perform in the plays are mostly from seven to fourteen years old. At this age they are in a fanciful stage of development; dry facts do not appeal to them, and hence milk is represented as being composed of fairy elements. The performance of these plays, the colouring and reading of the Health Book, and the talks to children on the value of milk in the diet has created in the children themselves an insistent demand for milk in the home. One can readily understand, therefore, that when this demand is voiced from all over the country, the production and consumption of milk is stimulated to a high degree.

The National Dairy Council is a cautious body and does not publish any material for use in schools which does not meet with the approval of the leading dietary specialists and of the leading educators. This approval is sought so as to ensure the ready acceptance of its literature by all teachers and health authorities.

The National Dairy Council functions not only as a school health agency, but also as a national health organisation. It works in close co-operation with Welfare Associations, with the National Red Cross, with the Anti-Tuberculosis League and with the School Nurses Organisation. Literature relating to milk and its products and the value of these in the home are extensively broadcasted among these organisations. Moving picture films are also issued. Last year there were sold 80,000 dollars worth of printed literature to Government Health Organisations alone.

The Quality Control Work of the National Dairy Council is an important department of its activities. In order that propaganda throughout the country for the more extended use of milk and its products may be effective, there is an obligation on the part of the industry to provide the best material for the consumer. The National Dairy Council helps to ensure this by engaging in educational work among the milk producers and the milk dealers. Farms and Milk Plants are visited and inspected and improvements suggested by the officers of the National Dairy Council.

All branches of the National Dairy Council co-operate closely with other agencies in an endeavour to improve the supply in the territories in which they operate. Educational work among the dairymen themselves is welcomed and highly appreciated. Personal contact with the dairyman who is producing the milk and the employment of educational motion pictures have stimulated rural interest to a high degree. Actual demonstrations of clean safe milk production are continuously given on farms where such demonstration is likely to be of real value.

So successful has the work of the National Dairy Council been in the fluid milk industry that recently its help has been sought by the trade to "boost" the use of ice cream as a food. The dealers and manufacturers must, however, give a guarantee that their products are made under exceptionally clean conditions from the best of raw material, and that the ice cream contains not less than 10 per cent. butter fat and 21 per cent. total milk solids (Calcium compounds, protein and milk sugar). The National Dairy Council is therefore about to undertake propaganda showing the public why ice cream is a good and safe food and advocating its use. In New Orleans the ice cream trade has promised financial support for this propaganda, the sum promised being 400,000 dollars.

FARM PESTS—BIRDS.[1]

JAMES RITCHIE, M.A., D.Sc., F.R.S.E.,
Natural History Department, Royal Scottish Museum.

BIRDS AND GRAIN CROPS (*continued*).

Wild Geese.—These handsome birds are so seldom seen by the majority of farmers that they could never be regarded as general pests. Yet in an island such as Great Britain, the many sheltered estuaries of which offer safe harbourage during the winter months so that it has become the rendezvous of multitudes of immigrants from the far North, they do more damage in certain maritime districts than might be supposed.

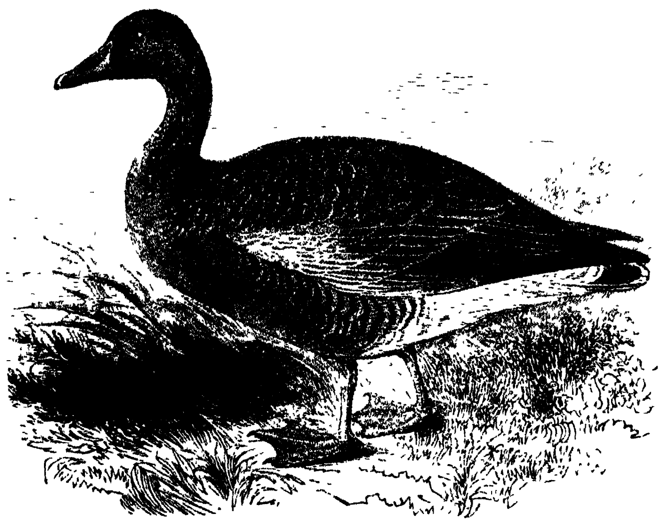
Of the eleven species of wild geese which have been recorded from Britain, only half-a-dozen occur in such numbers that they need concern us here, and of these only one, the Grey Lag, breeds in this country, and that in a very restricted area. They have many characters and habits in common. All are easily recognised by their resemblance in shape to the domestic goose, for domestication, in converting the Grey Lag into the tame goose of the British poultry yard, has done little but change the colour of the plumage and add a greater depth to the body. All are gregarious, all habitually spend most of their time on the mud-flats of estuaries, and in flight all form either a V-shaped skein or a long slanting line.

Sportsmen divide the half-dozen species of geese here referred

[1] Articles in this series, dealing with Mammal Pests, commenced in the JOURNAL in July 1922. The first article on Bird Pests appeared in January 1924.

to into two groups—the "grey geese," including the grey lag, the pink-footed, the white-fronted and the bean-goose, and the "black geese," including barnacle and brent geese. The grouping gives a hint of a colour character useful in discriminating between them. In the grey geese, belonging to the genus *Anser*, the head, neck and throat are rich brown in colour, the legs are some shade of red, and the bill when closed still shows from the outside the strong ridges which run across its inner surface. In the black geese, genus *Branta*, the neck and throat are black, the legs are black, and in the closed bill ridges are invisible from the outside.

The Grey Lag Goose.—The Grey Lag (*Anser anser*), the only resident species in the British Isles, was in earlier days widely distributed on moors and marshes throughout the country, but its



GREY LAG GOOSE.[1]

nesting area is now confined to western Sutherland and the Outer Hebrides, and even in these areas its numbers are gradually decreasing. Its general colour is rich brown, but it is distinguished by its ashy-grey wing coverts, lower back and rump, its flesh-coloured to orange-yellow bill with white tip or "nail," and its flesh-coloured legs.

Its nest is a large hollow formed in heather or thick grass, and the only lining is the down with which the eggs, as they are laid, become entirely concealed. Four to six large yellowish-white eggs, almost 3½ inches long, are laid in mid-April and the young generally hatch out in May. Geese are vegetarians. The resident birds feed largely upon short grass, clover or grain crops, and though their numbers are not very large, they may still do a considerable amount of damage amongst the sparse crops of the northern west coast and the Outer Isles. Partly on this account and partly because of the food value of the birds, which weigh

[1] The illustrations are from Saunders' *Manual of British Birds*, by courtesy of Messrs. Gurney and Jackson.

about 7½ lbs., numbers are sla[illegible] Wi[illegible] Birds Protection Acts) by fishermen and others during the period of moult, when the adult birds are unable to fly and the young are still flightless, though both take readily to the sea.

The most serious damage is done to crops in the early autumn, when resident birds begin to congregate. In the Outer Hebrides towards the end of August the flocks play havoc with the standing grain. Should the ears of corn be too high for them to reach by craning their necks upwards as they stand upon the ground, they destroy it by stratagem, as Mr. Fred Beveridge has recorded,[1] levelling it either by rising in small flocks and alighting close together in a selected spot, or each by using its wings, flail-like, to beat down the stalks. In this way they destroy even more of the crop than they devour.

From the latter part of September till mid-November, the numbers of the resident birds are augmented by large flocks of immigrants which have bred in Iceland and the far North, as many as five hundred having been seen on the wing at a time. Their habits are very regular; they are daylight feeders, visiting the cultivated land at daybreak, and, if opportunity has not offered earlier, watching for the departure of the field workers before raiding standing corn or stooks. At dusk they retire to the mud-flats or sand-banks by the shore, or inland to open moor or fresh water lochs, where they spend the night in safety. Only when they are subjected to molestation in the fields during the day do they reverse their habitual methods, and, spending the day restlessly at sea, fly inland to the feeding grounds at dusk or on moonlight nights. Throughout the winter they visit pasture fields, sometimes cropping the grass almost to the ground, and in hard weather they have been known to attack potatoes and turnips.

The winter damage is not confined to the areas inhabited by resident grey lags, for the immigrants settle in many parts of Britain, where estuaries offer suitable mud flats and sand banks, but they are much more common on the west than on the east coast. The migrant birds forsake Britain in March and April, but before they go they take toll of the young clover and sometimes of sprouting corn.

A curious method of keeping grey lags off the crops is described by Robert Gray in his "Birds of the West of Scotland" (p. 340). With reference to the Outer Hebrides, and in particular the Long Island, he wrote in 1871: The grey lag "is but seldom molested, save at the season when the slender crops are being gathered, and even then the native farmers prefer the practice of driving it off by lighting fires, to the extreme measure of powder and shot. For the last hundred years, indeed, the flocks of wild geese which collect about that season—and a very important one it is to these isolated husbandmen—have been kept at bay by fires alone. . . Several fires are made in the fields and kept burning night and day; by this means the crops are to a great extent saved; but the moment any of the fires is allowed to fail, the geese, which are continually shifting about on wing, suddenly perch on the unprotected spot, and often do much mischief before

[1] *Scottish Naturalist*, 1918, p. 73.

they are discovered." I do not know whether or not this hundred-year-old practice is still kept up, but I should imagine that the modern firearm has wholly replaced it.

Other Wild Geese.—The habits of the rest of the common grey geese have a general likeness to those of the grey lag, but these birds are present in Britain only during the months from autumn to spring. The earliest arrival, the pink-footed goose, generally reaches these islands from mid-September to mid-October, and the laggard of the group, the bean-goose, a fortnight later. They exhibit, however, curious preferences in the areas they select for their winter sojourn. The grey lags settle on the west coast, a favourite resort in Scotland being the Solway Firth, and are rare along the east coast; so also with the white-fronted and bean-geese, but the pink-footed reverses the preference, being abundant on the east coast, in such areas as Aberlady Bay on the Firth of Forth and the Tay estuary, and less frequent, although common in limited localities, on the west coast. This is probably the species of which complaints have reached the Board of Agriculture for Scotland from Stirlingshire and from Aberdeenshire, where they have been found to damage newly sown oats. All the species depart from Britain in March and April, though the bean may linger a little longer.

Of the three species, other than the grey lag, the white-fronted is of least agricultural significance since it prefers to haunt marsh land rather than cultivated areas and corn-fields. Dr. Harvie Brown, writing of Stirlingshire,[1] credited the bean goose with "punishing the farmer's newly sown beans in early spring, through the day, and as one of the fraternity informed me 'paiddling aboot i' the mud at nicht,—deil tak' them.'"

In some of their immature plumages the grey geese are difficult to distinguish from each other, but of adult birds it may be said that the commonest, the pink-foot, is rather small, 28 inches long, the rump is brown, the bill is black and yellow with a black "nail," and the legs and feet are pink; the bean-goose is larger, 34 inches, has a brown rump, a black and orange bill with black nail, and orange-yellow legs and feet; the white-fronted goose, 27 inches long, has a pale rump, an orange-yellow bill with white nail and orange-yellow legs and feet.

Of the black geese, the brent may be known by the white forehead and side of the head, contrasting with the general black of the remainder of these parts; while the barnacle has only a small white patch on each side of the neck. These birds, also winter visitors from mid-September and October till March and April, are more sea frequenting than the grey geese, but of the two the barnacle is the more given to visiting cultivated land in the neighbourhood of its maritime resorts.

The damage done by wild geese is very limited in extent, but owing to their size and voracity it may be serious enough within the limits frequented by them.

Damage by Birds not habitually Grain-eaters.—So far in this account of the relations between birds and grain crops attention has been directed to those birds which are largely or wholly vegetarian

[1] See Gray's "Birds of the West of Scotland," p. 344.

and which, by structure and habit, are adapted to a grain diet. It might reasonably be surmised that these are the most mischievous of grain pests, and on the whole that surmise is correct. Nevertheless there are a few birds, which although seemingly ill-adapted to make use of grain and habitually non grain-feeders, cause a certain and sometime serious amount of damage at particular seasons. These seasonal attacks seem to be determined by two factors; either that the concentration of grain in the course of ordinary farming operations offers a food-supply attractive on account of the ease with which it may be obtained, or because the normal food-supply is scarce at a time when the grain crop offers a welcome substitute.

The two periods which especially attract such birds are the autumn period when the corn is in stook and the spring or autumn time of the sprouting seed-corn. Take first the enemies of the stooks: they belong to three groups, the game birds, certain of the gulls and wild ducks.

Game Birds and the Grain Crops.—Game birds are of the gallinaceous tribe, to which domestic poultry, the turkey, peacock and guinea-fowl also belong. As such they are characterised by their ground-loving habit and by the possession of short wings, resulting in a rather heavy whirring flight, of a short stout bill and of four toes, armed with strong claws adapted for scratching. In feeding they are partly insectivorous, partly vegetarian, but four have been justly accused of damaging corn—the red grouse, the black grouse or black game, the pheasant and the partridge. Whether the damage is serious enough to counteract their many good qualities is another question.

The Red Grouse.—The red grouse, *Lagopus scoticus*, a bird peculiar to the British Isles, is widely distributed in Scotland, Ireland and Wales, and frequents the mountains of northern England south to Yorkshire, Derbyshire and Shropshire. It is essentially a moorland bird, "muirfowl" was the old Scottish name, and is most often, though not always, found on moors which are clad with heather. By nature, then, it frequents areas generally far removed from the most highly cultivated land, and there the adults feed in spring upon the fresh shoots of heather and crowberry, in summer upon the flowers and seeds of these plants, and in autumn upon heather tops and whatever wild fruits the moors yield, crowberries, blaeberries or wortleberries, cranberries or cowberries, and even haws where hawthorn trees grow in the vicinity. They also eat a certain amount of insect life by the way, chiefly beetles and two-winged flies (*Diptera*), but in this respect the old birds are much more abstemious than the chicks, which for several weeks of their life devour nothing but insects and other minute animal food.

Only in autumn, when the corn is gathered into stooks in the fields bordering the moor, do grouse forsake a wild for a cultivated diet, alighting upon the sheaves and clearing the ears of their grain. So well known is this habit that many a grouse is snared or netted by poachers on the stooks. The direct damage is bad enough, but it is added to by the further harm done through the treading down and shaking of the ears, and the wholesale fouling of the stooks by

droppings. After the harvest has been garnered grouse may be seen picking fallen grain, along with insects and other seeds, from the stubbles.

The damage done by grouse is very limited in extent, on account of their localised distribution, and in general (though not to the particular farmer or crofter affected) is more than compensated for by their harmlessness throughout the rest of the year and by their sporting and food value.

Black Grouse or Black Game.—As regards corn-crop damage black grouse, more commonly known, perhaps, as the black cock and grey hen, stand in much the same position as the red grouse. The British examples of black grouse form a distinct race, *Lyrurus tetrix brittanicus*, confined to Britain, and unknown even in Ireland. From the red grouse, the black cock differs in its glossy black plumage and in possessing the forked and outward-curving tail, which adds distinction to the bonnets of the nation's pipers. The grey hen, as her name indicates, is less ruddy than the female of the red grouse, and her tail is slightly forked.

What difference in degree there may be between the damage caused by red grouse and by black grouse is due to their somewhat different haunts For black grouse may be found at rather lower altitudes, and in preference to the open heather moor they select plantations and woods bordering the moor or cultivated land. Thus, while their food is very similar to that of the red grouse—the tips of heather, wild moorland berries and insects, with the buds, leaves and shoots of trees in addition—the frequent proximity of the nesting ground to cultivated land makes a raid upon the stooks a more common occurrence. Here, too, treading and fouling of the ears contribute to the extent of the damage. Black grouse also feed upon the stubbles, but that, like their diet throughout the greater part of the year, is harmless. Futhermore, their destruction of insects, which include multitudes of the harmful heather beetle (*Lochmæa suturalis*), must be reckoned to their credit.

The Pheasant.—The various races of pheasant now to be found in Britain differ from the other game birds in being aliens to the country, which have been introduced and naturalised by man for his own pleasure. They hail from different regions of Asia, the so-called old English pheasant, *Phasianus colchicus*, having probably originated in Western Asia, while the ring-necked pheasant, *Phasianus colchicus torquatus*, which has largely replaced the former in our coverts, is a native of central and south China Less common are the handsome Mongolian pheasant and the Japanese pheasant, distinguished by the dark green of its under parts. Pheasants have been long established in Britain; their remains, dating to an early century in the Christian era, have been found in a Roman station in England, but the evidence suggests that their establishment in Scotland belongs to a much later period, towards the close of the sixteenth century. The ring-necked pheasant was introduced about the end of the eighteenth century. Their long residence and wide distribution give them some claim to be regarded almost as on the plane of true natives, though the special care which man exercises over their nurture still hints at a certain degree of inadaptability to conditions in this country.

In contrast with the "muir fowl," the pheasant is a bird of the woodland, frequenting plantations especially where undergrowth affords good cover. Although essentially a ground bird it seeks safety at night by roosting on the branches of trees, a habit made ill use of by the poacher. Its diet is very miscellaneous. In the coverts and the fields it devours weed-seeds of many kinds, fallen beech-mast, acorns and berries, but it is also fond of grain, and occasionally does damage to fields of peas and beans, to clover, and in hard weather to turnips, where its pecking at the crown encourages the entry of rain and frost, and may result in speedy decay of the root. Country gardens are sometimes visited for the sake of their vegetables and flowering bulbs. In the corn-field it is objectionable partly because its weight beats down the standing corn as it alights, but the greater part of the grain with which pheasants' crops have sometimes been found crammed, seems to be picked from the ground rather than from the growing ear, and there are few more familiar autumn sights than a covey of pheasants picking over the stubbles after the crop has been cut.

There is, however, a very different side to its activities. As well as being a vegetarian, the pheasant is pronouncedly insectivorous, even trespassing beyond the limits of the insect world to devour snails and slugs, and on rare occasions small mice and reptiles, as many as eight young adders having been taken from the crop of a single bird. The extent of its beneficent warfare against harmful insects may be judged from the enormous numbers required to make a meal for so large a bird. Mr. P. H. Grimshaw found in the crop of a pheasant, received for examination at the Royal Scottish Museum, 2286 individuals of the harmful fly, *Bibio lepidus*, and 508 examples of the destructive heather beetle, *Lochmæa suturalis*, with other insects and mollusca making 2800 specimens in all, in addition to numerous portions of half-a-dozen different weeds. Other single pheasants have yielded as many as 1200 wire-worms and 440 leather-jackets or "grub," the larvæ of the daddy-long-legs, both notorious agricultural pests.

On the whole, and where the conditions approach those natural to the species, the pheasant is helpful rather than injurious to the farmer, but where excessive rearing of pheasants for sport takes place, the conditions are apt to be reversed, and Mr. Hugh S. Gladstone is of opinion that in numbers of more than one bird per acre it is liable to become harmful.

The Partridge. — The common or grey partridge (*Perdix cinerea*) is a native of Britain, unlike the pheasant and its own close relative the red-legged partridge, which was introduced to England from the Continent about 1770. Its choice of locality is characteristic, for it shuns the woods beloved of the pheasant, and as a rule sticks close to cultivated land, though occasional coveys are to be found on the higher pastures. It is the game bird most familiar to the highway traveller; not only does it nest in the thick undergrowth by roadside hedges, and under the shelter of bushes of whins and broom, but often a family may be disturbed on the roadway, to which it seems to be attracted either by dryness or warmth at times when the field crops are heavy with moisture.

As a native, the partridge is better adapted to natural con-

ditions in Britain than the pheasant, and can flourish without artificial aid. But the destruction of vermin contributes greatly to an abundance, which is helped by the large size of its broods, for while ten to fifteen eggs are the rule, it is not exceptional to find as many as twenty. Most common in the highly cultivated counties of eastern England, it is also frequent in the Scottish lowlands, and is widely distributed throughout the rest of the country.

The partridge feeds most eagerly in the early morning and evening, giving way to an enviable lassitude during the heat of the day. Its diet consists of grass and green foliage, of weed-seeds of many kinds, and occasionally of grain, which it is fond of gathering from the stubbles after the crop has been harvested. Its presence in a field of standing corn should not be regarded as evidence against it, for it seldom feeds upon the growing ear, and seeks the corn field rather for the shelter and insect life it affords. Many insects fall to its hunting, as well as small snails and slugs. There is abundant evidence of the good it thereby does to agriculture; wire-worms, leather-jackets, the larvæ of the turnip moth and similar field pests constitute perhaps the greater part of its food, and its preference for an insect diet was well shown during the recent plague of the antler moth in England, when partridges migrated to the upland pastures in search of the hordes of destructive caterpillars. Like pheasants they show a partiality for ants and their eggs and larvæ, perhaps because an ant-hill offers an abundant store well worth raiding.

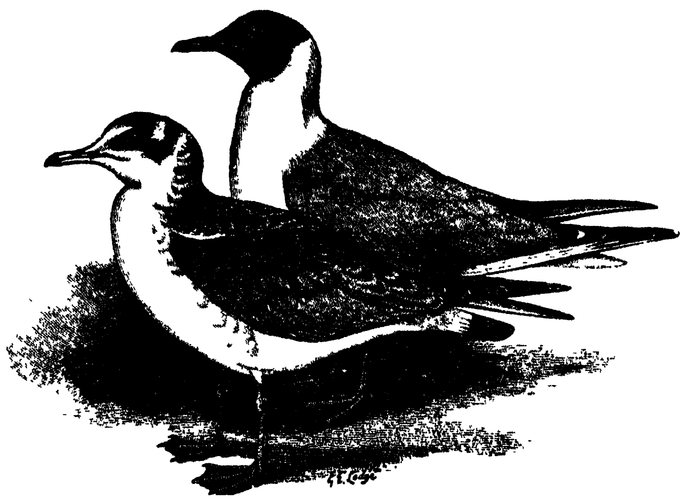
The insect food alone of the partridge far more than compensates for any harm it may do to grain crops, and there must also be added in its favour its destruction of weed seeds.

Changed Feeding Habits and the Grain Crops.--Nothing in nature is unchangeable, and it is not surprising to find that feeding habits, so dependent upon circumstances, do not remain fixed, but may alter suddenly or gradually, and sometimes to the detriment of the farmer. In our country such changes of dietary are due to one or both of two causes, both of which can be traced back to man himself. The farmer, in increasing the produce of the soil, displays an abundance of easily obtained food-stuffs which must tempt many a hard-pressed bird. The temptation is not likely to be effective where the natural food is different, so long as it is plentiful. Here man's second interference begins to tell His growing regard for living things has rightly led him to protect all but the most obnoxious birds, and this protection, made effective through the Wild Birds Protection Acts, has resulted in a remarkable increase in a large number of species. Increasing numbers have taxed the natural food supplies of certain birds, and scarcity has induced several to experiment on the farmer's crops, and where the experiment has been successful to turn to them in gradually swelling forces. Of the birds which can hardly be regarded as normal grain-feeders, but which are becoming more and more accustomed to attack the corn crops, the most outstanding are the sea-gulls and wild ducks.

Gulls and the Corn Crops.—The food of gulls is somewhat varied, but a large proportion of it is gathered by the sea-shore. There they may be seen treading the sand at the edge of the tide

for sea-worms, shrimps and other small crustaceans, or in rocky places feeding upon shore-crabs and molluscan shell-fish. It is a curious habit of some species that if they find the shells of the latter too hard to be cracked by beak alone, they may fly to a height with the crab or mollusc, letting it drop upon the ground or upon rocks, sometimes repeatedly, until the shell breaks. On the surface of the sea they paddle about in search of food, picking up small creatures, and sometimes making shallow awkward dives after small fishes. On land the lesser gulls feed on insects and their larvæ and on earthworms. In spite of the fact that their natural diet consists of such non-vegetarian food, three species of gulls have developed a liking for grain—the black-headed gull, the common gull and the herring-gull.

The black-headed and common gulls are often confounded, owing perhaps to popular names that are in some degree mislead-



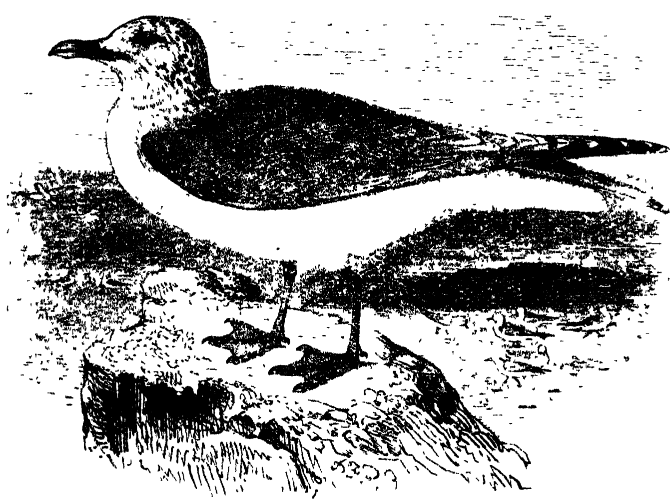
BLACK-HEADED GULLS.
The hinder bird is an adult in full summer plumage, the bird in front is a juvenile, assuming its brown head in its second spring.

ing. As their habits are not identical and in some counties the law treats them differently their distinguishing features must be pointed out. In the first place it must be remembered that the "common gull" is not the commonest of our gulls, and that the black-headed gull has not always a black or even dark head, and is as a rule more common on agricultural land than the former.

The Black-headed Gull.—In summer plumage, which the adult birds wear from about March to August, the black-headed gull (*Larus ridibundus*), is easily recognised by its sooty brown head and throat; but in winter head and throat become white except for a few grey feathers on top, and two dark spots, one beside the eye, the other behind the ear coverts. In full plumage the bill and legs are of a bright blood-red colour. The tip of the wing is black, and the white of its outer margin stands out against the pale grey of the remainder of the upper surface. More slender in build than the other gulls, this species is characterised also by the activity of its movements on land or in the air. The black-headed gull

occurs in greatly increasing numbers throughout Britain. It nests in social colonies in marshy places near the shore or far inland, even on moors a thousand feet above sea-level. Its food resembles that of all the lesser gulls, but it shows a more marked preference than others for cultivated land, where it follows the plough in company with the rooks, and may be seen skimming the fields in the evenings for insects hovering above the grass. In the autumn it may steal grain from the stooks or glean the stubbles, but all the evidence shows that its destruction of harmful insects, such as the leather-jacket larvæ of crane-flies and the crane-flies themselves, far more than balances the slight damage it does.

The Common Gull (*Larus canus*) has a much more limited breeding range than the black-headed gull, for although young birds may be found on all the coasts of Britain throughout the



COMMON GULL.

year, nesting, apart from an odd occurrence in northern England, is confined to Scotland, where the range extends from the Solway Firth to the far north.

In summer the head of the common gull is snowy white, but in winter grey streaks are interspersed with the white. The tips of the wings are black with a few white bars, the bill and legs are greenish yellow. Otherwise the body is snowy white except for the pale grey back and wings. The common gull is slightly larger than the black-headed, 18 inches long in contrast to the 15 or 16 inches of the latter, and its flight is more leisurely, with slower wing-beats. It nests in colonies on sea-side cliffs, or inland on moors or the islands of fresh water lakes.

The food of the common gull differs little from that of the black-headed, except in so far as the former is more a sea-bird and less an inland bird than the latter. Where the common gull is very common, as in some of the Hebridean islands, it has become

a persistent raider of the eggs of other birds. It occasionally follows the plough for the earthworms, insects and insect grubs that are turned up; and in the autumn it sometimes takes oats and wheat from the stook and from the stubble. Over all, the damage done to corn-crops is not very serious, but undoubtedly the increase of the common gull in some maritime counties has made it an agricultural pest the numbers of which might be reduced with advantage, since the benefit it renders the farmer as an insect destroyer falls far short of that accomplished by the black-headed gull.

The Herring Gull (*Larus argentatus*) is much larger than the two species already discussed, measuring as much as 22 to 24 inches in length, but it may also be distinguished from them by its yellow beak, which has a round blotch of bright vermilion at the angle of the under half, and by its flesh-pink legs and feet. It is the commonest of all our gulls along the sea-coast, where it nests on the cliffs or grassy islets, but though it is less frequently seen inland than either the black headed or the common gull its raids from the sea-side tend to increase in number.

The large size of the herring gull determines that its food should on the whole be coarser than that of the lesser species, and in this respect its habits approach those of the carnivorous black-backed gulls. It feeds on such carrion as it can find, dead dogs and cats or even sheep, it kills and tears the entrails from young rabbits, kills the sea-shore birds wounded by shore-gunners or rendered helpless by oil waste from steamers, steals the eggs of its neighbours of other species on the cliffs, and eats almost all kinds of shore invertebrates, crabs, worms and even star-fishes.

Yet this ravenous feeder leaves the shore for the crops of cultivated land. Of its attacks upon roots a word shall be said hereafter; there is abundant evidence of its love for grain. Gulls have a habit, after gorging themselves with food, of retiring to the top of a cliff for peaceful digestion, and there they eject in the form of pellets the undigestible residue of their meal. Little heaps of broken shells are littered about the cliff top, and often the heaps contain the husks of grain. When the corn has been cut the gulls descend in numbers upon the stooks, fouling much of the grain they do not devour. Professor J. Arthur Thomson has recorded in this JOURNAL (1924, p. 408) his alarm at witnessing the attack of herring gulls upon a splendid field of wheat in stooks: "Perched on the stooks were dozens of herring gulls gorging themselves with corn. We should think that there were at the very least two hundred herring gulls in that field, and they have big appetites." The gulls also feed upon shaken grain in the stubble, but that is a harmless ploy.

During recent years the Board of Agriculture for Scotland has received complaints of the damage done by gulls from several maritime and inland counties, ranging from Caithness, Ross and Cromarty, to Elgin and Nairn on the shores of the Moray Firth, Aberdeen, Argyll, Peebles and Dumfries; and while the kinds of gull concerned are seldom identified, specific complaints convict them of "damaging oats and wheat in stook." On this account a number of county councils have, through the Secretary for

Scotland, removed gulls, except the black-headed gull, from the protection of the Wild Birds Protection Acts; and this, in counties where there is good evidence of the serious turning of gulls to cultivated crops, appears to be a suitable step towards righting the wrong.

YOUNG FARMERS' CLUBS.

GEO. G. ESSLEMONT, M.B.E., B.Sc.,

Director of County Extension Work, The North of Scotland College of Agriculture.

History of the Movement.—The Young Farmers' Club movement had its origin in the United States of America in the early years of the present century. The Agricultural Department of Cornell University was the instigator of the movement, which arose out of a development of the nature study lessons in the elementary school. The movement spread rapidly to the various States, and it is estimated that there are close upon 5500 Young Farmers' Clubs in the United States of America at the present time, with a total membership of about 800,000 boys and girls between the ages of 10 and 18 years. The clubs are inaugurated by local branches of the County Farmers' Organisation, or in the absence of these, by local committees formed for the purpose. The local clubs are grouped under their respective county organisations, which are again linked up with the State Colleges of Agriculture and the Federal Department of Agriculture. The clubs are formed on a voluntary basis, and are expected to be self-supporting, but both the State and Federal Departments of Agriculture provide financial assistance for development and educational work. The promotion of the club movement, the instruction and training of members in club work, and the supervision of the organisation generally, form an important part of the county extension work of the State Colleges of Agriculture.

The movement spread to Canada in 1913, when Farm Boys' and Girls' Clubs, on similar lines to those in the States, were instituted in the province of Manitoba. Under the stimulus of increasing the food production of the country during the war, the number of clubs in the Dominion grew rapidly, particularly in the provinces of Alberta, Saskatchewan, Ontario and British Columbia. The number of Young Farmers' Clubs in Canada, and their total membership, are not available, but it is reported that there are at the present time over 35,000 club members in the province of Manitoba alone.

The idea of arousing keener interest in agricultural life and work amongst farm boys and girls, through the influence of the club movement, has also caught on in most of the progressive agricultural countries of the world, and considerable progress has been made in the movement in Australia, New Zealand, South Africa, the Argentine, Sweden, Denmark and Holland.

Through the enterprise of the *Daily Mail*, in co-operation with several of the large Dairy and Pure Breed Societies in the South

of England, Young Farmers' Clubs were inaugurated in this country in 1921. The first club was formed at Hemyock, Devon, under the auspices of the "United Dairies, Limited." This club was a success from the first, and the fact that its present membership is 150 augurs well for its continued success and usefulness. The primary purpose of the *Daily Mail* in organising the "*Daily Mail* International Federation of Young Farmers' Clubs" in this country was the increased production of food. Under this stimulus, 31 Clubs were established in Great Britain within two years of the inauguration of the first club at Hemyock. The need for increased food production having passed, the *Daily Mail* has recently abrogated its position in the management of the club movement in this country. The Ministry of Agriculture has taken over the supervision of the clubs instead, and has appointed an inspector to organise and co-ordinate their activities, and to advise and assist local bodies who may desire to promote or extend the movement. At the present time there are 25 clubs in active operation in this country, 20 in England, 1 in Wales, and 4 in Scotland. The total membership of these clubs is approximately 370.

Club Work and its Purpose.—The idea behind the Young Farmers' Club movement is to provide an opportunity for young people in country districts to supplement their school education by such home instruction and training in agriculture and rural domestic subjects as will serve to equip the farm boys and girls of to-day to become the skilled and capable farm workers and home-makers of to-morrow, and to create an interest in and love for all things appertaining to the open life of the country. Club membership also provides the opportunity to members to foster the spirit of co-operation and mutual help which is so necessary for the success of a common cause, to practice the conduct of affairs on business lines, to cultivate habits of accurate observation, to exercise independent judgment, and through the experience gained at club meetings to express their thoughts with confidence and moderation and to be tolerant of the views of others. In other words, the club movement aims at doing for country boys and girls what the Boy Scouts, Girl Guides and similar Organisations do for the boys and girls of the city, with this additional advantage, that the club movement is more utilitarian in its purpose in that the education and training which it provides is an apprenticeship for members to the farming occupation which they propose to follow out in after life. A programme of club work in a well organised American scheme is varied and comprehensive. It embraces the care and feeding of all kinds of farm animals, the growing of farm and garden crops, the carrying out of projects relating to dairying, poultry-keeping, bee-keeping and other minor branches of farming, competitions in club work, educational meetings for lectures and demonstrations in agriculture and rural domestic subjects, educational camps, social meetings, games, etc., etc.

In regard to the practical work, a club may decide to take up one subject only for the session, such as pig-keeping, bee-keeping, etc., when the club may be termed a "pig club," "bee club," etc. In most cases, however, the members choose one and not more

than two practical subjects from an approved list. Records of work must be kept in all cases and reports furnished to the club. Exhibitions of the practical work are also given when possible at suitable centres in the district. The club and county leaders exercise supervision of all club work. Certificates of merit are issued by the Agricultural Colleges to all members who show satisfactory completion of record books and of the subjects of training.

Development in Scotland.—The Young Farmers' Club movement began in Scotland in the spring of 1923. The originator of the movement was Mr. John Robson of Lynegar, Watten, Caithness, who became interested in the scheme through reading accounts of the American calf clubs in the Chicago Breeders' Gazette. Preparatory to inaugurating the movement, Mr. Robson submitted the matter for consideration at a meeting of the Caithness Advisory Committee of the College of Agriculture, of which he is convener. The committee heartily approved the proposal, and recommended that the district county organiser of the college should assist Mr. Robson as far as possible to form one club at least in the county as an experiment. After considerable inquiry, Lanergill, Watten, was selected as the most likely centre for a successful club, with the result that the first Young Farmers' Club in Scotland was inaugurated there in April 1923.

The prominence given to the movement through the success of the Lanergill experiment has led to the formation of three similar clubs in the neighbouring counties, i.e., one each in the counties of Orkney, Sutherland, and Ross and Cromarty. The following is a list and particulars of the Young Farmers' Clubs to date in Scotland :—

Name of Club.	County.	Practical Work.	No. of Members.	Date Instituted.
Lanergill ...	Caithness.	Pig feeding, field crops, and experiments.	24	1923
St. Ola	Orkney.	Rabbit-keeping and field crops.	18	1924
Birichen ...	Sutherland.	Poultry-keeping.	20	1924
Logie-Easter ...	Ross and Cromarty.	Poultry keeping.	23	1925

The club rules provide for the admission of associate members by payment of a small subscription. These are adults over 18 years, and are usually the parents of the members. There are 10 associate members of the Lanergill Club.

The Lanergill Club.—As the Lanergill Young Farmers' Club was the first of its kind in Scotland, a brief account of the procedure adopted in its inauguration, and the nature of the club work, may be of interest and assistance to others who may contemplate the promotion of similar clubs elsewhere in Scotland.

The first step was the formation of a local advisory committee, consisting of Mr. Robson of Lynegar, Mr. Sutherland, the local schoolmaster, and Mr. A. W. Black, B.Sc. (Agr.), District County

Organiser of the Agricultural College. Having decided on Lanergill as the most likely centre, the committee proceeded to call a public meeting of the parents and children in the district. Little enthusiasm was shown in the proposal at first, and it was only after some persuasion that a sufficient number of young people between the ages of 10 and 18 years was enrolled and office bearers appointed. Mr. Robson was elected patron of the club, while Mr. Sutherland, schoolmaster, and Mr. Black, county organiser, were appointed as club leader and county adviser respectively. The club was formed under the auspices of the *Daily Mail* International Federation of Young Farmers' Clubs, and the rules of the Federation were adopted.

The first business meeting of the club was held at Lynegar Farm on 9th April 1923, when each member was presented by Mr. Robson with a Large Black six weeks' old pig in exchange for a note of hand guaranteeing payment for the pig when sold as fat. Advice was also given in regard to the feeding, housing and management of the pigs. Each member was provided with a score book for recording particulars of the practical work.

The programme of club work for the first year comprised:—

(1) Practical training in the feeding and management of the club pigs, keeping monthly records of the weights, foods consumed, and making observations on the work.

(2) Theoretical instruction in pig-keeping, and other appropriate subjects, by means of lectures given by the officials of the Agricultural College, the Rowett Research Institute, and by persons interested in the welfare of the club.

(3) Excursions to selected farms, along with members of the local classes of the Agricultural College, for the purpose of receiving demonstrations in the judging of various kinds of farm stock, and to inspect field experiments carried out by the College.

The season's programme was concluded with the sale of the club pigs at a public sale of pigs held at Lynegar Farm on 2nd October 1923. A pig fed by a girl club member made the top price of the sale for fat pigs. Prior to the sale the club pigs were judged and placed in order of merit for prizes. Following the sale, the money received for the pigs was disposed of in accordance with the rules of the club as follows: The initial price of the young pigs was paid to Mr. Robson, 10 per cent. was paid into the funds of the club, and the balance was handed to each member to pay for the pig's keep, and to form a nucleus for a fresh start in pig keeping or some other form of practical work the following year.

At the farm stock demonstrations, competitors took a keen interest in the judging competitions, in which one or two girl members showed to advantage. Prizes were given to the owners of the three best pigs judged at the sale, also for the best essays on the season's work. Similar procedure was adopted in the inauguration of the other three Clubs in the North, but the practical work was varied to suit local circumstances. In all cases the local staffs of the Agricultural College took an active part in organising the clubs and assisting with the educational and practical work.

In the second year the practical work of the Lanergill Club comprised the growing of ten cross bred varieties of oats produced by Messrs. M'Gill & Smith, Seed Merchants, Ayr, which were presented to the club by Mr. Robson. Each member grew one variety along with a seed of each of the parents. Records of growth were kept and the seed saved. Collections of farm grasses and other plants of agricultural importance were also made for which prizes were awarded.

This year the club members are engaged in a potato growing competition, for which 3 cwts. of King Edward seed potatoes were supplied by Mr. Robson. A potato manuring experiment is also being carried out, the manures having been provided for the purpose by the Potash Syndicate.

Social and Educational Benefits.—Probably the most difficult educational problem in this country at the present time is the provision of an adequate and attractive course of education and training for farm lads and girls between the ages of 15 and 20 years, in so far as that is required to fit them to be efficient farmers and home-makers. Continuation classes embracing a variety of vocational and cultural subjects, applicable to rural requirements, are freely offered by the various education authorities, but these do not fully attain their objects in many rural districts through lack of interest on the part of the young people for whom they are intended.

The Junior Agricultural Clubs, or Young Farmers' Clubs as they are called in this country, were started in America partly as a solution of rural depopulation and partly with a view to the development of agriculture by the improved education and training of the mass of farm boys and girls. That these clubs have attained their object to a very large extent is evident to anyone who cares to inquire into the movement and its results. It seems clear that similar results could be obtained in Scotland by the development of Young Farmers' Clubs, with slight modifications in the American plan.

The Young Farmers' Club is a voluntary organisation, and requires little or no financing. The parts necessary for putting the machinery of the club organisation into operation are all at hand, and only require to be assembled, fitted and put in motion. Agricultural societies, local branches of the Farmers' and Farm Servants' Unions, local advisory committees, voluntary committees of individuals interested in the welfare of the young people, would be suitable bodies to undertake the inauguration of local clubs. Local schoolmasters would make ideal club leaders. The county organisers of the Agricultural Colleges could act as the county leaders and organisers, and supervise the club work of the respective counties, while the directors of county extension work of the Agricultural Colleges might form the connecting links between the various county clubs, and organise and supervise inter-county club work in their areas. The Board of Agriculture for Scotland, in co-operation with the Scottish Education Department, might supervise and co-ordinate the club work on a national basis. As already indicated, the scheme would be a voluntary one, but a small grant would be required for the purely educational work—the grant to be administered through the Agricultural Colleges.

LAND SETTLEMENT FOR DISABLED EX-SERVICE MEN.

P. A. M'WILLIAM, N.D.A., N.D.D.

DURING the later years of the war and the earlier post-war years State-aided training in horticulture, pig and poultry keeping was given at various centres to a number of selected disabled ex-service men. On satisfactorily completing the prescribed course, generally of from one to two years in duration, these "trainees" became eligible for settlement on small holdings, and went to swell the already large number of applicants for land settlement on the lists of the Board of Agriculture for Scotland. These disabled applicants had little or no value on the labour market, and in many cases required an open air life to maintain their partially restored health. Settlement on holdings of a size in keeping with their financial circumstances and within the scope of their physical ability to undertake, offered an opportunity to put their training into practice, and held out possibilities of enabling them to supplement their pensions and to bring up their families under more favourable conditions than they could hope to do in the towns, especially in those cases where they would be almost entirely dependent on pension for the support of the household.

A number were given holdings on the general schemes of land settlement throughout Scotland, but in 1922 there were still many for whom no provision had been made. In most cases these disabled men were from the towns, and had wives with little experience of life in the country, so that any great change in environment would have tended to make them discontented and would have militated against their success. On account of disablement, small capital and in many cases experience limited to the period of training, they were only fitted to handle efficiently a very small area of land. Consequently it was necessary in selecting a scheme for this type of applicant to have good land, in good heart, convenient to a good marketing centre, and, if it were near a military hospital where the men could attend for periodic medical examination and if need be for treatment, so much the better.

With the foregoing considerations in view, the Board of Agriculture towards the end of 1922 bought the farm of Damhead on the Lothianburn-Penicuik road, about five miles from Edinburgh General Post Office and just outwith the city boundary. This farm had an area of about 300 acres arable, and in addition to the requirements sought after, was suitably intersected by good roads and had a Corporation water main passing through the property, thus ensuring a good supply of water. A scheme was constituted for the formation of 36 new holdings, 3 of which are of 28 acres and 33 between 5 and 8 acres in area. The three larger holdings were designed to make use of the existing steading and are of such a size that, if a pair of horses are kept, work can be undertaken for the tenants of the smaller holdings, who otherwise would require to go further afield. They have been equipped with new houses of four apartments with scullery, larder and w.c. One of the houses is of the two-storey type, the other two are bungalows. The exist-

ing steading has been subdivided to form three steadings, each having a byre for 12 cows, 2-stall stable, granary, cart shed, pig pens, cattle court and boiler house. Dairies and dairy sculleries have been built conveniently placed to the dwelling-house and steading. The holdings are being developed as milk-producing dairy holdings, for which they are favourably situated. The holders settled are men who have had life-long experience in farm work.

The 33 smaller holdings have been equipped by the erection of 29 new houses and by the alteration and repair of the six farm cottages to form four houses. In every case the accommodation consists of three apartments with scullery, larder and w.c. Except in five instances the houses are built in pairs A new steading with byre for two cows, store, two pig pens and a boiler house has been built on each holding. The water supply is obtained from Edinburgh Corporation, by whom the holders are assessed in the usual way. The farm house being unsuitable for conversion into holders' houses was sold by public auction.

In land settlement schemes the buildings on a holding are erected by the holder with the aid of a loan from public funds, the Board of Agriculture being the bondholders. The loan is repayable by means of an annuity over a period of years at a low rate of interest. The annuity is a charge on the holding in addition to the rent of the land, and to prevent overburdening with annual charges, the equipment provided on all types of holdings is limited to the essentials required to give the holder a fair start. At Damhead the cost of equipment, including the value of the existing buildings, works out at an average of approximately £1300 for the three larger holdings and of approximately £600 for the 33 smaller holdings. In addition to the loans for buildings, grants amounting to about £4100 have been made for the provision of material for fencing boundaries, for making roads and for providing and laying water pipes. The average annual charge for land and buildings is just under £72 for the larger holdings, and rather more than £23 for the smaller holdings. Although the responsibility for the erection of the buildings rests on the holders, the Board give assistance by preparing plans, taking offers from contractors and by arranging for the supervision of the work, but should any holder prefer to carry out the work on his own account he is at liberty to do so. As a general rule no work can proceed until all the documents incidental to ingoing have been completed, but on Damhead a concession was made whereby the work of erecting buildings was carried out in advance of the selection of the applicants, who knew what they would get in the way of buildings before they were required to come to a decision regarding settlement. A start was made with building work in the spring of 1923, the first settlers got entry at Martinmas 1923, and thereafter entry was given as the holdings were ready for occupation, the settlement being completed at Martinmas 1924.

The qualifications required in an applicant for settlement were disablement contracted during war service; experience and capital and other things being equal, preference was given to those appli-

cants who had been trained at the expense of the State. Twenty of the 33 smaller holdings have been filled by "trainees," the remainder by applicants who had previous experience in agriculture, pig breeding, poultry keeping or market gardening. The pre-war occupations represented are very varied. Amongst the holders are to be found engineers, fitters, joiners, blacksmiths, barmen, regular soldiers, commercial travellers, tinsmiths, wicker weavers, ships' stewards, contractors, etc. Nearly all are very seriously disabled. Four of them, who are blind, were trained at Newington House —the Scottish Blinded Soldiers and Sailors Hostel—and are in no way behind others in the management of their holdings. Some have lost a limb, others have badly disabled limbs, and there are cases of severe head and body wounds. A characteristic of the disabled men is optimism, and in this connection the remark made by a holder who is quite blind when a holder who is quite deaf was introduced may be quoted, "Man, isn't it remarkable that ye aye meet somebody who has a greater handicap than you have got yourself."

Each man decides for himself the lines on which he will develop his holding, his choice being to some extent limited by the nature of his disablement. Poultry keeping for egg production is the mainstay, but there are three pig breeders and feeders and two market gardeners. In some cases a cow is kept to supply the household with milk and at the same time to permit of one or two calves being fed for veal; in other cases goats are relied on for the milk supply. Nearly all keep a few feeding pigs and one or more breeding sows. The blinded men are poultry keepers, and some others specialise in the production of day-old chicks.

After settlement a holder's energies are in the first instance directed to laying out the holding, to rearing stock and to providing additional housing accommodation in advance of the needs of the stock. This demands a considerable outlay for food stuffs and materials before any appreciable return can be had from the holding, and it is at this stage that a holder's courage is most severely tried. At this time the man with knowledge and ability to buy and make use of sound second-hand material scores over his less qualified neighbour.

During the first two years it is difficult to form a correct opinion regarding the progress of any particular individual, and a holder oftens doubts for a time his own ability to make a living out of the small area of land at his disposal; but with well directed application to the work and constancy in his efforts he gains confidence in himself and his doubts disappear. At Damhead it is evident that several are already on the right lines to make their holdings pay, and are so far advanced with stock and equipment that further outlay on these is likely to be insignificant. In a few cases old wounds have reopened and a further period of hospital treatment has become necessary. Where this occurs, in spite of the best endeavours of a holder's wife and family, things get somewhat out of hand, and convey to the casual observer an entirely wrong impression regarding the capabilities of a really good man.

On all schemes of land settlement co-operative trading is a valuable aid, but on a new scheme, where the men are drawn from a wide area and are in most cases entire strangers, it takes some time before any scheme of co-operation can take shape. Experience gained in buying food stuffs and materials and in selling produce in individual small lots soon impresses the majority with the need for co-operation. At Damhead a co-operative trading society has recently been formed, and on a site feued from the Board the society has built a hall, store and caretaker's house. The object of the society is to buy in quantity the food stuffs, etc. required by its members and to sell the produce of the holdings, chiefly poultry and eggs.

The convenient situation of the store to the public road and the demand for new laid eggs by Edinburgh residents, warrants the belief that the produce of the scheme will be readily disposed of at retail rates. The hall will be used for meetings and recreation, and it is hoped that a telephone exchange may be provided by the Post Office.

As already indicated, it is rather early to express a definite opinion regarding the progress of the scheme. but there is every promise that the majority of the present occupiers will make good and that the expenditure will be justified on agricultural and social grounds, particularly when it is borne in mind that the scheme is providing homes and healthy employment for men who have deserved well of their country.

THE following article has been contributed by C. G. T. Morison, M.A., School of Rural Economy, Oxford.

Soil Stabilisation: a Grassland Problem.

At this time, when the return of much land to grass, and its subsequent management, is occupying the attention of many farmers, it becomes increasingly important to recognise the essential differences that are to be found between grass land soils and those of arable land.

In arable soils there is a certain soil zone in which there is little variation in composition and properties in a vertical direction even in this climate, owing to the fact that these soils are subject to frequent disturbance as far as the layer that is cultivated is concerned, though the region below this may show differences more or less analogous to those which develop in undisturbed soils. In other words, there can be little differentiation in different horizons in the case of arable soils as the material is inverted and intimately mixed at least once in every year, and it is only when this region is passed in a downward vertical direction that conditions become such that there is a perceptible change from one horizon to the next. The extent to which this is true will depend of course on the extent to which percolation exceeds evaporation, and will largely depend on the rainfall, so that while in Scotland and the west of England, with a rainfall of over 40 inches in the year, even an arable soil will suffer a certain amount of impoverishment, it will clearly be less than will be suffered by a soil which is undisturbed, owing to the fact that the zones of incipient differentiation are

mixed so frequently. When arable land is laid down to grass the soil immediately becomes subject to differentiation in a vertical direction and impoverishment of the surface layers will take place.

The percolation stream in the soils of this country will consist of two main types.

In the absence of calcium carbonate, owing to the formation of acid humus on the surface when for some reason or other the decay of organic matter has been hindered, there will result an acid percolation stream which will tend to dissolve absorbed bases from the soil colloids and will in the end remove oxides of iron and aluminium, bleaching the layers immediately underneath. In the presence of calcium carbonate there will be a percolation stream of water containing more or less calcium bicarbonate in solution, with the result that the soil colloids are constantly bathed with this solution and saturated as far as calcium is concerned.

These two types of percolation streams will produce different results—the first will tend to form an unsaturated soil, which may be regarded as the first step in the direction of the "podsol" type, which is so notoriously infertile; the second results in a loss mainly of calcium bicarbonate to the soil, and until that substance has been reduced to a very small amount this type will not pass into the other with all its consequent drawbacks. It is therefore clear that the resting of the soil, while it may result in a gain of nitrogen, does tend to produce a condition in which the more soluble basic constituents at any rate are in danger of disappearance from the surface layers.

It has generally been supposed that the migration consists only of the movement downwards of iron and aluminium; but it has been shown that this is not so, but that there is also a loss of calcium, magnesium, potassium and sodium, and indeed it may be doubted whether much removal of iron and aluminium takes place until the concentration of the soil water becomes very low. Nor is it only these substances that are affected in this way, as there is evidence to show that there is a loss of phosphate, which may result in an impoverishment which will be most detrimental to the quantity and quality of the succeeding herbage.

These results may account for the fact that in those regions of this country in which rainfall is comparatively high and summer temperatures are comparatively low, there is considerable difficulty in maintaining quality in permanent grass. It has, for example, been clearly shown by Mr. Orwin in a recent issue of the Journal of the Ministry of Agriculture that while during the last few years the change from arable land has been to permanent grass in England it has been to temporary grass in Scotland, where the rainfall is greater and evaporation less owing to the lower temperatures in summer. The writer of this paper wishes to urge that these grass soils are only special instances of a perfectly general phenomenon that occurs in all undisturbed soils when this acid layer is developed on the surface. The problem of preventing this downward migration of important soil constituents is not one that is capable of easy solution, but as far as the available information goes there is no similar change that takes place when the soil contains calcium carbonate. The precise effect exerted in

this case upon the nutrient materials by the solution which is always in contact with them appears uncertain, but there would appear to be no losses at all comparable with those that occur when this substance is absent. It would therefore appear desirable that, wherever calcium carbonate is not a normal constituent of soils, this substance is particularly necessary when the change from arable to permanent or temporary pasture is contemplated. It is, therefore, recommended that in sowing down land to permanent or temporary pasture enquiries should always be made from the local advisory officers as to whether the soil stands in need of liming, and, if so, in what form and in what amounts lime should be added. In order that the lime may exert its maximum stabilising effect upon the soil it is important that it should be present in sufficient quantity to bring the soil beyond the neutral point, which point can be ascertained with sufficient exactness by modern methods of soil investigation. Furthermore, liming at a subsequent date cannot have the same result, as the mischief has in great measure occurred, and it is therefore unlikely that it will have an effect upon the amount of material at the disposal of the plant, though it will of course prevent the mischief going further. The author is informed by Professor Somerville that it was always the practice in time past to put on dressings of lime in Scotland at the time of sowing down land to temporary pasture. This practice seems largely to have died out, which is unfortunate, as the stabilisation of undisturbed soil in the above view appears to depend on the presence of lime. It is, of course, realised that the resulting damage may vary considerably with different soil types, and will reach a maximum with a sandy type and be reduced to a minimum in a heavy soil, where the amount of substances available for leaching will be much greater. In other words, this action will be a limiting factor in grass production at an earlier date in light soils than it will be in heavy, but the result will be the same ultimately in both cases. The more acid does the surface layer become the more rapid will be the change, as not only will the removal proceed at a greater rate, but also a very acid layer tends to eliminate worms from the soil, which under other circumstances bring back to the surface some at any rate of the finest materials, causing a distinct movement to some extent analogous to cultivation.

It is now realised both by farmers and by others interested in the management of land that there are many problems connected with the formation and maintenance of good grass land on which much more information is desirable, and in the author's opinion this change in character and composition of the soil in a vertical direction has been too often overlooked. Recent work in Oxford has given an indication that variations of the nature described may seriously affect the growth of forest trees, and if that is so it is to be expected that the vegetation of a grass field would be more intensely affected. The three controlling factors seem to be:—

(*a*) absence of lime;
(*b*) rainfall;
(*c*) porosity of soil.

It ought to be possible with further investigation of this problem to indicate for definite climatic conditions the soil type in which the danger point is most likely to occur. Until this is done it seems to be desirable that farmers contemplating putting down land to permanent or temporary grass should insure against this risk by the application of lime at the time when the change is made.

THE following article has been contributed by Professor R. G. Linton, Department of Hygiene, The Royal (Dick) Veterinary College, Edinburgh.

The Composition of Poultry "Mixed Grains."

The interest at present being focussed on poultry nutrition and poultry diseases led to the thought that it might be profitable to enquire into the composition of the mixed grains that are offered to the poultry keeper by dealers in foods. That such an investigation seemed to be necessary was clearly shown by the frequency with which undesirable parcels of food were found being fed to chickens and hens. Furthermore, it seemed possible, indeed probable, that the feeding of grains either in themselves naturally unsuitable or hygienically unsound owing to deterioration might be associated with the unthriftiness and illness commonly met with in flocks of birds.

The following is a record of the examination of the first 50 consecutive samples of mixed grains sold as "chicken food" and 37 consecutive samples of "poultry mixed grains." These samples have been sent in from England, Scotland, Wales and Ireland, and may be taken as being fairly representative of the kind of food commonly purchased by poultry keepers other than those who buy straight grains and do their own mixing.

Chicken Mixed Grains.—Samples sent in were intended for chickens from one day up to three months old. As in many cases the age of the chick for which the food was intended was not stated it has not been possible to group the samples into separate lots, a clear distinction, however, is made between *chicken food* intended for young birds and *poultry food* intended for adult birds. An analysis of the 50 samples showed that no less than 23 different food materials, excluding grit, are utilised by chicken food mixers, and it is an astonishing fact that only two samples were found to have the same combination of grains, clearly showing that there seems to be little or no agreement among poultry food vendors as to the combination of grains best calculated to give good results. Table I. is a statement of the food materials found, together with the percentage of their frequency of occurrence. In the last column of the table are given the extremes of the proportion in which they were found in the mixtures; for example, maize varied from 1 to 33 per cent. of the total mixture.

TABLE I.

Chicken Foods.

Food.	*Percentage of frequency.*	*Proportions found.*
Maize	98	1–33
Wheat	86	5–70
Pinhead Oatmeal and Groats	56	3–87
Millet (*Panicum miliaceum*) ...	56	0·5–30
Dari	48	1–27
Canary Seed (*Phalaris canariensis*)	46	1–32
Rice	34	1–20
Buckwheat	30	2·5–20
Hemp	20	1–8·5
Linseed	14	0·5– 4
Meat and Bone Meal ...	12	3–10
Oats (whole)	10	1–60
Barley	10	3–20
Lentils...	10	0·5– 4
Pearl Barley	8	2–14
"Dried Fly" (*Corixa*) ..	8	trace–10
Split Peas	6	1– 2
Guinea Corn[1]	6	0·5–13
Biscuit Meal	4	3– 4
Gram (*Cicer arictinum*) ...	2	17
Tares	2	2
Millet (*Panicum crus galli*) ...	2	4
Flaked Maize	2	13
A decorticated millet (undetermined)	2	7
Rubbish, over 2 per cent. ...	44	2–27
Rubbish, a trace or *nil* ...	44	—
Grit or Gravel, over 2 per cent.	12	2–16

The maximum number of different seeds present in one sample, excluding weed seeds, was ten, on one occasion only two different grains were found while the average number was six. Grit or gravel was present in appreciable quantity on six occasions, the following percentages by weight being found:—3·4; 8; 8; 15; and 16 per cent. The grit in most instances was not clean sharp grit such as is desirable for poultry, but was smooth pebbly gravel. Apart from the doubtful utility of giving chickens smooth grit, the practice of including gravel, or grit, in mixed grains sold by weight, gravel included, seems scarcely one to be encouraged. The poultry feeder could, it may be supposed, purchase his grit at a cheaper rate and of better quality if bought as grit, separate from the grains. As regards the hygienic quality of the mixtures, of the 50 samples examined 76 per cent. could be classed as good, and in 24 per cent. the grains were of such inferior grade that the samples could only be classed as bad and really not fit for feeding to young chickens. Furthermore, while 24 per cent. were graded as bad, owing to the inclusion in the sample of a large proportion of damaged grains, as many as 44 per cent. of the mixtures examined

[1] A variety of Dari (*Sorghum vulgare*) which is marketed with the glumes attached.

contained over 2 per cent. of "rubbish," 14 per cent. contained over 10 per cent. and one sample was found to have as much as 27 per cent. of rubbish. The debris classed as "rubbish" consisted chiefly of weed seeds. It is clear that many chicken mixtures have as their basis tail-wheat and weed seeds both of which have been removed from imported grains in the process of screening for the purpose of cleaning the grain prior to milling. In some of the samples examined the percentage of weed seeds was such that one could only conclude that they had been added for the purpose of deliberate adulteration. Much of the tail-wheat used is of such inferior quality that it would not be passed as fit for chicken food by a veterinary hygienist. There is little doubt that some of the weed seeds are harmful to chickens. For example, Corn Cockle (*Agrostemma githago*), a very common weed seed in screenings from some imported cereal grains, is often met with in inferior samples of chicken grains, and in one of the samples examined was present to the extent of 3·2 per cent. by weight of the grain, together with 9·3 per cent. of other weed seeds. Darnel (*Lolium temulentum*), the toxicity of which is doubtful, was not common, but in two samples 40 grains and 50 grains respectively were found in 100 grammes of the mixed grain. Of the weed seeds identified *Polygonum convolvulus* is certainly that most frequently met with. Its presence is most objectionable, because if not consumed by the birds it contaminates the ground on which it is thrown and when it is eaten may be the cause of intestinal troubles, at least in young birds, as the hard and pointed seed-coat seems peculiarly liable to cause laceration of the delicate lining of the gut. Apart from the possible harmful effect to the birds of the incorporation of such rubbish in grain mixtures no poultry keeper wishes to sow weeds broadcast on to his land, neither should he be required to purchase weed seeds at the price usually charged for sound chicken food. It is not uncommon to find grain mixtures containing over 10 per cent. of weed seeds sold at 16*s.* per cwt., so that out of a ton of "mixed grain" 2 cwts. of weed seeds may be purchased for 32*s.* But it is of course possible that some of the weed seeds may form a valuable addition to the chicken's diet. A number of cases of deaths in chicks investigated at the Royal (Dick) Veterinary College recently by the writer's colleague, Professor D. C. Matheson, have proved to be cases of impaction of the bowels due to indigestible fibrous material taken in with the food. Such coarse material may also do considerable damage by lacerating the delicate lining of the chick's bowels.

An attempt was made to correlate the different samples examined with the object of determining the grain mixtures for chicks most commonly compounded by vendors, but as only two samples were found to possess any similarity this has not been possible. It is difficult to suggest what is the guiding principle that leads poultry food vendors to adopt any particular combination of grains. If it is that each dealer thinks his own combination is the ideal mixture, one can only conclude that their opinions are very diverse. It would appear, therefore, to be largely a matter of chance if the purchaser of mixed grains buys a suitable mixture or not. As so much of the material marketed is distinctly

inferior in quality, and as the proper feeding of chickens is of paramount importance if success is to be ensured, then it is clear that there is need for poultry keepers to exercise great care in the selection of their foods.

Since this enquiry was closed the writer came upon a "chicken mixture" composed entirely of screenings consisting of exotic seeds such as unhusked rice, *Dolichos uniflorus*, *Phaseolus mungo*, *Phaseolus aconitifolius*, several other varieties of the *Phaseolus sp.*, *Cajanus indicus*, a host of exotic weed seeds and a considerable proportion of earth. For this mixture the purchaser had been charged £8, 10*s.* per ton, and the chickens refused to eat it.

Poultry Mixed Grains.—Much less variation was found in the combinations of grains than was the case with chicken mixtures. Fourteen different foods were contained in the 37 samples examined, their percentage of frequency and the extremes of the proportion in which they were found in the mixtures being shown in the following table:—

TABLE II.

Poultry Foods.

Food.	*Percentage of frequency.*	*Proportions found.*
Wheat	100	9–79
Maize	94	2–65
Oats	93	3–72
Barley	65	1–26
Dari	57	1–22
Peas	6	3– 5
Flaked Maize	6	11–64
Guinea Corn	6	7–12
Gram	3	5
Biscuit	3	7
Sunflower Seed	3	6
Rye	3	8·5
Hemp	3	8
Tares	3	5

As compared with chicken mixtures, there would appear to be a more constant combination of particular grains. The most popular combination is maize, oats, barley and dari, which occurs in 32 per cent. of the samples examined; maize wheat and oats, and maize, wheat, oats and barley combinations each occur 22 per cent. of times. As with chicken foods there is no constant proportion of one particular seed to another in similar mixtures. Only 10 samples of the 37 could be classed as really good, and 12 were distinctly bad owing to mustiness and marked inferiority of grains. Three samples contained gravel or grit in the following high proportions, 13, 17 and 32·5 per cent. Weed seeds and rubbish were not so prevalent as in chicken foods; but there were three outstanding cases where they occurred, one sample containing 13 per cent., one 14 per cent. and one as much as 22 per cent. of weed seeds and dirt. One sample was sent in for examination as it was suspected to have caused the deaths of eight hens within

half an hour after eating the mixture; it was found to contain about 3 per cent. of damaged wheat which gave a high yield of sugar. By a curious coincidence similar wheat was recovered from a sample purchased in the same locality.

The present enquiry has dealt only with "seed mixtures," and as such a large percentage of chicken and poultry foods compounded of *unground* seeds has been found to consist of unsound and undesirable constituents it may be reasonable to suppose that *ground* grains, for dry and wet mash feeding, will not be more desirable when prepared by unscrupulous dealers or by those who do not realise how important sound food is to the birds.

Summary.—A critical examination of 87 samples of chicken and poultry mixed grains has shown that in many cases the mixtures are compounded of very inferior grains, and that screenings from imported cereals often constitute a considerable proportion of the mixtures. On the other hand some of the samples are very good indeed. Experience has shown that improper feeding of chickens is often responsible for mortalities. Poultry food vendors, in general, do not seem to be guided by any knowledge of nutritive requirements in the selection of grains and the compounding of mixtures. In commercial grain mixtures insect food was only found four times in 87 samples examined; in view of the presumptive importance of insect protein to chickens its further use might be made more general. It is questionable if seeds with hard and smooth seed-coats, such as canary seed and millet, form an ideal food for young chicks.

This opportunity is taken of expressing thanks to those who kindly sent samples of food for examination, to Dr. Graham of the Royal Botanic Garden, Edinburgh, for identifying some of the grains, and to Dr. R. Stewart Macdougall for his identification of the dried fly used in the mixtures.

THE following article has been contributed by Sir Jas. Wilson, K.C.S.I.:—

Farm Wages and Working Hours in Scotland in Summer 1925.

In a statement recently issued by the Board of Agriculture giving the rates of wages for farm labour at present prevalent in Scotland, they have, in calculating the cash value of the allowances given in addition to the cash wage, adopted for the whole country the following values:—Meal 20*s.* per cwt.; Milk 1*s.* per gallon; Potatoes £4 per ton; House £6 per annum; Coal 35*s.* per ton; Board and lodging for single men 14*s.* per week; Bothy accommodation, with attendance, £9 per annum, without attendance, £6 per annum. These rates do not differ greatly from those adopted by me in my article published in the JOURNAL OF AGRICULTURE for October 1924, and I take them as the basis of the calculation for this summer.

As regards married men, the arithmetical averages of the statistics now given by the Board (after omitting those which are not strictly comparable), work out as follows for all the Counties of Scotland put together.

Average Weekly Earnings of Married Men in Summer 1925.

	Cash.		Allowances.		Total.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*
Ploughmen	29	11	8	5	38	4
Cattlemen	30	0	9	1	39	1
Shepherds	30	0	9	5	39	5

The average cash wages of all these classes are practically the same, namely 30*s.* a week, and attention may now be confined to the case of the married ploughmen, who form the most important part of the body of farm servants.

Married Ploughmen.—In the eastern part of the central industrial area, which comprises Fife, South Forfar and the Lowland part of Perthshire, the married ploughmen are generally engaged for a year from Martinmas, and there no change had been made in their cash wages at last Whitsunday; but in the rest of Scotland new bargains are made with them at Whitsunday, generally for a year, except in the Lower Clyde Valley in the neighbourhood of Glasgow, where six months' engagements are the rule. The result of these arrangements is at present approximately as follows. (I have re-calculated the values of the allowances, taken into account newspaper reports of the results of the hiring fairs, and rounded off the figures, which can only be roughly approximate.)

Average Weekly Earnings of Ordinary Married Ploughmen in Summer 1925.

County or District.	In Summer 1924. Cash.	In Summer 1924. Allowances.	In Summer 1924. Total.	In Summer 1925. Cash.	In Summer 1925. Allowances.	In Summer 1925. Total.
	s.	*s.*	*s.*	*s.*	*s.*	*s.*
Wigtown	23	14	37	24	15	39
Kirkcudbright	34	4	38	34	4	38
Dumfries	34	4	38	33	4	37
Selkirk	33	5	38	33	5	38
Roxburgh	33	5	38	33	5	38
Berwick	35	5	40	35	6	41
Peebles	36	5	41	35	5	40
East Lothian	35	4	39	37	5	42
Midlothian	37	4	41	38	5	43
West Lothian	38	4	42	38	5	43
Stirling	37	4	41	40	3	43
Dumbarton (Lower Clyde Valley)	38	4	42	40	4	44
Lanark, N.W. (Lower Clyde Valley)	38	4	42	40	4	44
Renfrew (Lower Clyde Valley)	38	4	42	40	4	44
Ayr, North	37	5	42	38	5	43
Ayr, South	36	4	40	37	4	41
Lanark, S.E.	34	4	38	36	4	40
Clackmannan	40	1	41	40	1	41
Fife, S.W.	32	10	42	40	1	41
Fife, N.E.	28	11	39	30	12	42
Kinross	32	10	42	29	11	40
Perth, S.E.	27	11	38	29	11	40
Perth, Central	25	11	36	26	11	37

County or District.	In Summer 1924.			In Summer 1925.		
	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.
	s.	*s.*	*s.*	*s.*	*s.*	*s.*
Forfar, S.W.	28	11	39	31	11	42
Forfar, N.E.	31	11	42	31	11	42
Kincardine	27	11	38	29	11	40
Aberdeen, East	24	11	35	26	11	37
Aberdeen, N.E.	23	11	34	24	11	35
Aberdeen, Central	23	11	34	23	11	34
Aberdeen, S.W.	23	11	34	23	11	34
Aberdeen, N.W.	23	11	34	23	11	34
Banff, N.E.	26	10	36	25	11	36
Moray	26	11	37	26	11	37
Nairn	23	12	35	24	12	36
Inverness, East, ...	22	12	34	23	11	34
Ross, East	24	12	36	24	13	37
Sutherland, East	18	15	33	18	13	31
Caithness	16	14	30	16	15	31

The arithmetical average for this summer for these 38 Counties and parts of Counties is 38*s.* 11*d.* (cash 30*s.* 10*d.*, allowances 8*s.* 1*d.*), which may be compared with my revised estimate for summer 1924 of 38*s.* 1*d.* (cash 29*s.* 11*d.*, allowances 8*s.* 2*d.*), an average increase of about 1*s.* a week in the cash wages. The present average weekly earnings of married ploughmen for all Scotland may be taken as 39*s.* a week, as compared with 38*s.* last summer and with 22*s.* in summer 1914, an increase of about 77 per cent. above the pre-war level. According to the *Labour Gazette* the cost of living is now (August 1925) 73 per cent. above what it was in July 1914, so that the average married ploughman is still in a position to maintain his family at the standard of comfort they had attained immediately before the outbreak of war.

Practically everywhere in Scotland the married ploughman is provided with a house and garden, free of rent and rates, and with certain allowances, such as oatmeal, potatoes, milk, coal and firewood, which vary considerably from one part of the country to another and even sometimes from man to man. Curiously enough, in Wigtown the custom still is to pay a large proportion of the weekly earnings in kind, valued at 15*s.* a week, although in the other counties south of the Forth and Clyde the allowances in kind are only of the value of from 4*s.* to 6*s.* a week and the cash wages proportionately higher, while north of that line the allowances in kind are again much larger and vary in value from 11*s.* up to as much as 15*s.* a week, with a corresponding reduction in the cash wage. Including cash and allowances the average weekly earnings of a married ploughman in the southern counties of Scotland are from 37*s.* to 39*s.*; in the south-eastern counties, including the Lothians, they are from 40*s.* to 43*s.*; in the Lower Clyde Valley, 44*s.*; in the rest of the central industrial area from 40*s.* to 42*s.*; and north of Kincardine they gradually become less in value, until in Caithness they amount only to about 31*s.* In the West Highlands the number of married ploughmen employed is comparatively small, and statistics regarding their wages and

allowances vary considerably and hardly admit of being averaged. They are reported as amounting to 36*s.* a week in the Lewis, 50*s.* a week in central Argyll, and 40*s.* a week in Kintyre.

Single Ploughmen.—The wages paid to single men vary greatly according to their varying experience and capacity. In the South-Eastern Counties, where the single ploughmen are generally engaged for a year from Whitsunday, get no allowances, and live with their parents or relatives, the reporters give the average cash wages at about 35*s.* 6*d.* per week, as compared with 34*s.* last summer, varying from 33*s.* in Roxburgh and Selkirk to 37*s.* in the Lothians. In the rest of Scotland the single men generally make a new bargain every six months. In the Lower Clyde Valley and North Ayr the single ploughmen are reported as getting on the average about 23*s.* a week (as compared with 21*s.* last summer), besides board and lodging, which may be valued at 14*s.* In Forfar and South-East Perth, where the single men usually live in bothies and get fire and light and allowances of oatmeal and milk, which may be valued at 7*s.*, the cash wages are reported as from 34*s.* to 37*s.* a week. In the north-eastern counties, where the single men generally get board and lodging now valued at 14*s.* a week, the cash wages of single ploughmen are reported as averaging 22*s.* a week, or much the same as last year. In Inverness, Sutherland, Caithness and Shetland single men receiving board and lodging are reported as having cash wages from 14*s.* to 20*s.* a week. There seems to have been in the last twelve months a somewhat larger rise in the cash wages of single ploughmen than in those of the married men, and their total earnings may now be estimated as averaging for all Scotland about 36*s.* a week (cash 23*s.*, allowances 13*s.*), compared with 39*s.* for the married ploughmen.

Agreements between Unions.—Generally speaking, arrangements regarding wages, allowances and working conditions are made between individual employers and workers, and the only areas in which joint agreements between the Farmers' Union and the Workers' Union seem to have had much effect at last Whitsunday are East Lothian (where both sides agreed to an increase of 3*s.* per week for men and 2*s.* for women), North Ayr, Clackmannan, South-West Fife and Caithness. A conference was held between representatives of the two Unions for Mid and West Lothian but failed to reach agreement, the farmers offering an increase of 2*s.* a week for men and 1*s.* for women, while the workers claimed 1*s.* more in each case.

Women Workers.—In the South-Eastern Counties (Roxburgh, Berwick, East Lothian and Midlothian), it is common to employ women to work in the fields, engaging them for a year from Whitsunday at a cash wage fixed at so much a week, plus a harvest fee of from £1 to £2, and sometimes a small allowance of potatoes. These additions may be reckoned as worth about 1*s.* a week for all the year round. Their average earnings were about 13*s.* a week in 1914, and are now about 24*s.* (cash 23*s.*, allowances 1*s.*), as compared with 23*s.* last year. In the rest of the country women working on farms, on other than temporary engagements, are generally employed as dairymaids or kitchenmaids, and are boarded and lodged in the farm-house. A common cash wage for a dairymaid is £20 for the

half-year, but some experienced women get up to £24. An experienced kitchenmaid gets about £18 or £20 in the half-year. Casual women out-workers are generally paid at the rate of from 3*s.* to 4*s.* a day, averaging about 3*s.* 6*d.*, and sometimes rising to 5*s.* a day during harvest and potato-lifting.

Working Hours on Farms.—The conditions regarding working hours vary considerably from county to county, and even sometimes on neighbouring farms; but, broadly speaking, the position is at present somewhat as follows:—In the short days of winter the working hours are from daylight to dark. On the other hand, in harvest and seed-time, the workers are generally expected to work for ten hours a day, without any payment for overtime, though sometimes a harvest fee of £1 or £2 is given. The usual summer day's work is for nine hours in Selkirk, Roxburgh, Berwick, Peebles, the Lothians, Clackmannan, Fife, Kinross, Forfar, Kincardine, Banff, Inverness, Ross, Sutherland and Caithness; nine and a half hours in Dumbarton, Renfrew, North-West Lanark, North Ayr, Perth and Aberdeen; and ten hours in Wigtown, Kirkcudbright, South-East Lanark, Dumfries and Stirling, and in the Highlands and Islands, when the weather is fine. Except in harvest, when work is required for the full six days a week, it is usual to grant a half-holiday on Saturdays in Berwick, the Lothians, Stirling, Dumbarton, North-West Lanark, Renfrew, North Ayr, Clackmannan, Fife, Kinross, Perth, Forfar, Kincardine, Inverness, Nairn, Ross and Sutherland; but in Wigtown, Kirkcudbright, Dumfries, Roxburgh, Selkirk, Peebles, Aberdeen, Banff, Caithness and the Highlands and Islands it is more usual to have no regular Saturday half-holiday, but to give each man a few days' holiday on full pay when desired in a slack season. Almost everywhere the workers are given holidays, without loss of pay, on New Year's Day, hiring-fair days and local show and sports days. In addition to the ordinary working hours, the ploughman has to spend on the average about an hour a day, including Sundays, in attending to his pair of horses.

THE following article has been contributed by A. C. M'Candlish, M.S.A., of the West of Scotland Agricultural College.

Conserving Swedes for Milk Production. The methods of preserving the swede crop for use in winter and spring vary from district to district. Where the land is wet and heavy or the winters severe the swedes are generally lifted and pitted in late autumn. Elsewhere the roots are ploughed in, or, more generally, allowed to grow untouched until spring. There are two general methods of ploughing in swedes—either the growing swedes are earthed up with the drill plough, or two or more rows of roots are pulled and put into a newly made furrow and then the earth thrown back on them with the plough. The second method is the more common, but it requires more labour. The first method, simply earthing up, is very simple and of low cost per acre.

It is claimed that both methods prevent the swedes from

rotting, and it is also stated that roots so preserved have a greater feeding value than either those allowed to grow or those preserved in pits. In addition, it has been shown that ploughed in roots can make considerable growth during winter.

The Roots Used.—The roots grown for this preliminary trial were Imrie's Improved Purple Top Swede, produced on a high-lying, sloping, well drained field of light soil. They were weighed on 19th November 1924, and those lifted for weighing were pitted and covered with straw and earth. On 21st November some were earthed up with a drill plough while others were allowed to grow undisturbed. A sample of the roots as they grew in the field was taken for the determination of the dry matter content. On 3rd March 1925 the roots in the pit were again weighed, as were both plots in the field. Samples of all three were taken at this time for the determination of dry matter.

TABLE I.

Yields and Analyses of Roots.

(Analyses furnished by Chemistry Department.)

Plot.	Yield Per Acre.	Dry Matter Content.	Dry Matter Per Acre.	Gain of Dry Matter.	
				Since Autumn.	Over Pitted.
	T. C. Q.	%	Lbs.	%	%
Autumn	21 3 3	11·30	5463	...	...
Pitted	21 3 1	11·07	5248	-4	...
Growing	22 6 3	10·83	5419	-1	3
Ploughed up ...	25 3 2	10·98	6192	13	18

When the total yields of roots per acre are considered it is found that there was a slight loss in the pit as compared with the autumn weights. The swedes that were allowed to grow showed an increase over the autumn and spring weights of the pitted roots, while those that were ploughed up increased markedly as compared with the other plots.

It is for the dry matter in them that roots are grown, though the value of their succulent character must not be neglected, so the yields of dry matter per acre need attention. The swedes that were ploughed up gave 6192 pounds of dry matter per acre in spring, or 13 per cent. more than the autumn yield, 14 per cent. more than the spring yield of the growing roots, and 18 per cent. more than the spring yield of the pitted roots. That is, the ploughed up roots gave a larger yield in the spring, in both total weight and weight of dry matter per acre, than did those that were pitted or allowed to grow unprotected.

The Feeding Trial.—A feeding trial with the roots that had been earthed up and those that had been allowed to grow unprotected was started on 22nd February 1925 with eight grade Ayrshire cows. The majority of the cows were in their prime and all were in the early stages of lactation when the trial started.

The trial consisted of three periods of twenty-five days each, divided into two sub-periods of ten days each and one of five days.

The five day sub-periods were looked on as transition periods and the data from them are not presented here. The milk was weighed at each milking and composite samples for each cow were kept for ten day periods and tested for butter fat.

The ploughed-up swedes were fed during the first and third periods and the growing swedes during the second period. Sixty pounds per cow per day were allowed in three feeds. The roots were brought from the field as needed during the first and second periods and the first half of the third. It was then necessary to lift the remainder of the ploughed-up roots to prevent them from running to seed and to clear the land for spring work.

In addition to the roots 7 pounds of oat straw and 9 pounds of good mixed hay per cow per day were allowed. The concentrate mixture, which was fed according to the production of the cows, consisted of 4 parts soybean meal, 3 parts ground oats, 2 parts wheat bran and 2 parts distillers' dried grains by weight. The roots and concentrates were weighed for each feed, while the allowance of hay and straw was controlled by occasional weighings. The cows were provided with salt blocks and were allowed out one to two hours daily for water and exercise.

TABLE II.

Production Summary.

Period No.	Swedes Used.	Milk Yield.	Fat Yield.	Fat Content.	Concentrate Consumption.
		Lbs.	Lbs.	%	Lbs.
I.	Ploughed up	5869	194·22	3·26	1785
III.	Ploughed up	6107	217·60	3·56	2009
Average ...	Ploughed up	5988	205·91	3·44	1897
II.	Growing	6234	210·10	3·37	1900
Increase over Growing Roots, per cent.		-4	-2	2	0

In the summary of the yields the total production of the eight cows is given by twenty-day periods. The concentrate consumption was practically constant, and as the consumption of roots and dry roughages was uniform throughout the trial, any changes in production that occur may be attributed to differences in the roots.

There are very slight variations in production—a somewhat lower yield of milk and butter fat when the ploughed-up roots were fed. This is perhaps of no great significance, however, as three cows showed increases and five decreases in milk yield and four increases and four decreases in fat yield when the ploughed-up swedes were fed as compared with the yields obtained from the growing roots. It is probably safe to conclude, therefore, that, ton for ton, the ploughed-up swedes and the growing swedes were of equal value for milk production. In view of the closeness of the dry matter contents this was to be expected.

Summary.—With the soil and climatic conditions under which this trial was conducted, the yield of swedes, both total yield and

dry matter yield per acre, was increased by earthing up as compared with the yields obtained when the roots were pitted or allowed to grow unprotected throughout the winter. The earthed-up swedes and the growing swedes appeared to be of about equal value, ton for ton, for milk production, and so the increased yield resulting from earthing up the roots would lead to greater milk production per acre of crop.

Electrical Power in Farming.

IN the report of the Scottish Conference on Agricultural Policy proposals are made with regard to supplies of electrical power and to its application in agriculture. It is accordingly of interest to note that the subject is dealt with in a report published in the August Journal of the Institution of Electrical Engineers. In referring to this report a writer in a recent issue of *Nature* says:—

"The extending use of electricity in agriculture abroad has turned the attention of many supply engineers in Great Britain to the investigation of its possibilities. The conditions which lead to an economic use of electrical power in farming are different in various countries. In Sweden, for example, the transmission lines from the waterfalls pass along the valleys in which the agricultural areas are situated. In this case the lines can be readily tapped and the farmers supplied at a low price. In Holland many lines are in existence traversing agricultural land on their way to supply towns or the electric pumps used for drainage purposes. In Switzerland also the lines supplying the semi-domestic factories can be readily tapped. In France, however, the shortage of man power makes it necessary to use electric power, and military reasons make it advisable to maintain the agricultural areas at their maximum efficiency and make them as attractive as possible to the population, even at the expense of the State. In Italy there is a super-abundance of hydraulic power from the Alps in the summer time when the industrial demand is a minimum and the farming demand is a maximum. Financial assistance is given by the State to rural distribution lines in Italy, Canada and Scandinavia. In some of the districts abroad the supply is remunerative and some progress has been made in Great Britain. Most electrical engineers believe that the electrical equipment of all our main line railways is merely a question of time. When it is accomplished there will be many distribution systems in existence from which a supply to agricultural areas could easily be given at remunerative rates. The cost of an overhead system to supply farmers is about £500 per mile; this is mainly due to strict government regulations. In Sweden the cost is sometimes so low as £100 per mile. It looks as if we would have to wait until the advent of electric traction before much progress can be made in applying electricity for the benefit of British agriculture."

Scottish Agricultural Research Conference.

THE Third Annual Conference of Scottish Agricultural Research workers and teachers was held in Edinburgh on 22nd, 23rd and 24th July. There was an attendance of about a hundred drawn from the Research Stations, the Agricultural and Veterinary Colleges and the Universities, together with representatives from the staff of the Board and a few visitors, including Lord Novar, Mr. James Elder, Mr. R. J. Young, Professor J. H. Shepherd, Dept. of Animal Husbandry, North Dakota, and Professor Clark of Iowa, U.S.A.

The programme opened with a visit to the College Farm at Boghall, where demonstrations were given by members of the University and College staffs of the various lines of experimental work in operation, including improvement of hill pasture, variety trials of cereals and potatoes, manurial experiments, grass mixture trials and single grass plots, meteorological station, and sheep-breeding and calf-rearing experiments. Those interested in poultry were shown over the Board of Agriculture's National Egg-Laying Test plant at Seafield on land leased from the College.

At the Conference held in the University Agriculture Class-room in the afternoon an address was given on the "Economic Management of Men and Horses" by Mr. R. J. Young, who was introduced to the meeting by the chairman, Lord Novar, as one of the most successful and advanced farmers he had met in Australia. Mr. Young's paper, the substance of which is printed on page 382 of this JOURNAL, was an original and suggestive contribution and provoked considerable discussion.

For the rest of the Conference the chair was occupied by Sir Robert Greig, who welcomed the delegates and expressed the gratification of the Board at the success of these conferences and their belief in the advantages accruing from them both to the workers in the different lines of agricultural research and to the College lecturers.

At the first session, papers were read by Mr. J. O. Veatch of Michigan Agricultural College, U.S.A. on "Soil Survey Work in America"; by Dr. W. G. Ogg, Soils Advisory Officer, Edinburgh, on "Soil Investigations and their bearing on Field Experimental Work"; by Mr. W. H. T. Williamson on "Soil Acidity"; and by Mr. A. Cunningham on "Some Effects of Acidity on the Bacterial Flora of Soils."

The second day was taken up with visits to the station of the Scottish Society for Research in Plant Breeding and the Board's Seed Testing and Plant Registration Station, both of which are situated on the farm of East Craigs, Corstorphine.

At the former the members of the Conference were welcomed by Mr. James Elder, President of the Society, who as a practical farmer and seedsman emphasised the need for research bearing upon the development of British agriculture. Demonstrations and explanations of the work of the station were given by the Director, Mr. James Robb, and his assistants, Messrs. Grigor and Sansome.

At the Board's station for Seed Testing and Plant Registration, Mr. Thomas Anderson, Superintendent, and Messrs. A. Millar and G. Gilray accompanied parties round the buildings and the field plots and explained the organisation of the work.

The third day's proceedings began with a paper-reading conference at the University Agriculture Classroom, where contributions were submitted by Mr. William Godden, Rowett Research Institute, on the "Importance of the Mineral Contents of Pastures"; and by Dr. J. M. Henderson, also of the Rowett Institute, on the "Influence of Ultra-Violet Light on Nutrition."

A visit was then paid to the Royal (Dick) Veterinary College in Summerhall Square, where demonstrations and preparations illustrative mainly of work on animal diseases were shown by Principal Bradley and Professors Mitchell, Matheson, Greig and Linton.

In the afternoon the meeting was held at the University King's Building, where the Animal Breeding Research Department is housed. Papers were read by Mr. J. E. Nichols on "Fertility in Sheep"; Mr. J. A. F. Roberts on "Wool Improvement in Welsh Sheep"; Miss J. S. S. Blyth on "Microscopic Examination of Wool"; and Mr. A. D. B. Smith on "Inheritance of Coat Colours in Shorthorn Cattle." The visitors were shown over the various rooms and the outbuildings of the Department, and had an opportunity of seeing the large number of interesting experimental animals used by Dr. Crew and his staff in their investigations into heredity problems.

The Conference closed with votes of thanks to the local Committee and the Secretaries, Messrs. J. A. More and W. T. H. Williamson, to whose admirable arrangements the success of the meetings was mainly due.

Agricultural Scholarships.

THE following is a note of agricultural scholarships awarded annually by the Board of Agriculture for Scotland. Awards for the present year have now been made.

Scholarships for Children of Agricultural Workers.—In accordance with the provisions of section 3 of the Corn Production Acts (Repeal) Act, 1921, under which funds were provided for promoting agricultural development, including scholarships and maintenance grants for the sons and daughters of agricultural workmen and others, the Board in 1922 inaugurated a scheme for the award of scholarships in four classes as follows:—

Class I. Short Course allowances, not exceeding 35*s.* per week for the period of the course, to enable the holders to attend short courses of from four to ten weeks' duration in agriculture, horticulture, dairying, poultry-keeping, etc.

Class II. Certificate Course Scholarships, each not exceeding £30 in value, to enable the holders to attend courses of instruction in agriculture, horticulture, dairying, poultry-keeping, etc. These courses as a rule require attendance at classes during one session of about twenty weeks.

Class III. Diploma Course Scholarships, each not exceeding £120 in value, or £40 per session, to enable the holders to attend the courses of instruction for diplomas awarded by

Agricultural Colleges in Scotland. These courses as a rule require attendance at classes during three sessions of about twenty weeks each.

Class IV. Degree Course Scholarships, each not exceeding £360 in value or £120 in any one year, tenable for courses of instruction for the degree of B.Sc. (Agriculture) of a Scottish University during three academic years or thereby, or for the qualification of M.R.C.V.S. at the Edinburgh or Glasgow Veterinary College.

In addition to the allowances described above, class fees are paid in respect of all scholarships awarded. Travelling expenses may be paid either in addition to, or wholly or partly in place of the allowances.

The scheme is administered by the Board, with the assistance of the Scottish Education Department, Education Authorities, Colleges of Agriculture and the Scottish Farm Servants' Union.

Benefits under the scheme are confined to:—

(*a*) The sons and daughters of agricultural workers;

(*b*) The sons and daughters of other rural workers, including smallholders, whose financial circumstances are comparable to those of agricultural workmen;

(*c*) Persons who are themselves *bona fide* workers in agriculture, or its allied pursuits, whose financial circumstances are comparable to those of agricultural workmen.

Research and Post-Graduate Scholarships.—These scholarships are intended to provide training for research work for graduates who show distinct promise of capacity for advanced study and research in some one of the sciences bearing on agriculture. The scholarships are of two classes:—

(1) Scholarships of the value of £200 per annum, tenable for a period of three years, open to graduates with honours in science (or equivalent qualifications) of a British University. In the case of Veterinary Research Scholarships, applicants must have obtained the Diploma of the Royal College of Veterinary Surgeons or have shown evidence of proficiency in medicine or some other related branch of science.

Applications for the scholarships are considered by the Development Commissioners' Advisory Committee on Agricultural Science, on which both the Ministry of Agriculture and Fisheries and the Board are represented.

(2) Scholarships of the value of £120 for one year, with a possibility of extension in exceptional cases for a second year. When the scholarship is tenable at Oxford or some other centre where the cost of living is unusually high an increased award may be made.

Applicants must be graduates of a British University.

Nine scholarships are awarded annually, provided a sufficient number of suitably qualified applicants is forthcoming. The

selection of candidates under this scheme is carried out by the Board.

Agricultural Scholarships for Students intending to become Agricultural Organisers, Lecturers, etc. — This scheme, which is administered jointly by the Ministry of Agriculture and Fisheries and the Board of Agriculture for Scotland, is intended to further the education of selected agricultural students who propose to take up posts as agricultural organisers, teachers or lecturers in agriculture. Candidates must be British born and should be graduates of a University, but exceptional candidates otherwise qualified, who have not had an opportunity of graduating, are regarded as eligible.

The scholarships, of which five are available for award annually, are of a maximum value of £200 per annum and are tenable for a period of two years, the second year being spent abroad, when special additional allowances to meet travelling and other expenses will be granted.

The selection of candidates is made by the Advisory Committee on Agricultural Science.

Travelling Research Fellowships.—In addition to the scholarships described, the Ministry of Agriculture and Fisheries and the Board of Agriculture for Scotland in 1924 introduced a joint scheme for the award of Travelling Research Fellowships, to enable members of the Agricultural Research and Advisory staffs to visit foreign countries in order to gain a first-hand knowledge of the progress being made elsewhere in their special subjects. These fellowships are available for short periods up to about six months, and the amounts of the awards are fixed by the Advisory Committee on Agricultural Science, by whom the successful candidates are selected.

Land Drainage and Unemployment.

DURING the coming autumn and winter the funds at the disposal of the Board of Agriculture for Scotland for the assistance of agricultural drainage will be so strictly limited that they do not anticipate that they will be in a position to invite the submisson of fresh applications for grants. Priority of consideration will therefore be accorded to the large number of suitable applications which were refused during the past two seasons owing to the exhaustion of the available funds. The maximum grants to be offered this season will be at the rate of 30 per cent. of the total cost of works, as compared with the previous rate of 50 per cent. The other conditions with regard to the labour to be employed, rates of wages, etc., remain unaltered. It is to be noted, however, that the funds will be available for land drainage work only, and not for farm roads, water supplies, etc. as previously.

This will be the fifth successive winter season during which the drainage scheme has been in operation, and it has been decided that, after the end of the coming winter, no further grants for land drainage will be available from the monies provided for the

relief of unemployment. Particulars of previous schemes are as follows:—

Scheme.	Government funds available.	Applications received.	Amount of grants applied for.	Applications approved.	Amount of grants approved.	Estimated number of men employed for varying periods.	Actual amounts paid by Board in grants.
	£		£		£		£
1921–22	40,000	419	27,835	290	21,854	1,400	14,822
1922–23	64,725	1,245	82,300	1,163	62,540	4,200	38,555
1923–24	45,125	1,340	81,000	745	45,125	3,100	31,788
1924–25	43,500	1,857	109,543	726	43,500	*	15,422†
Totals	£193,350	4,861	£300,678	2,924	£173,019	8,700	£100,587

* Not yet ascertainable. † To 31st August 1925.

The figures relating to the acreage improved under the 1924-25 scheme are not yet available, but it is estimated that during the first three years over 14,100 acres of arable land and 554,000 acres of other land were improved.

Fees for Seed-Testing.

THE scale of fees for the testing, etc. of samples at the Board's Seed Testing Station has been revised as from 1st September. The principal alterations which the revised scale involves are:—

(1.) The fee in the case of certain grass seeds and certain species of garden seeds which present greater difficulties in analysis than the others is raised by 1*s.* per sample.

(2.) Where purity and germination tests of mixtures of grasses and clovers are made, with separate tests of each constituent, a flat rate is substituted for the present charge per ingredient.

(3.) The fee for a Dodder Test alone is raised from 1*s.* to 5*s.*

(4.) Fees double those specified in the scale are charged for special reports in the terms required by foreign regulations in respect of seed to be exported.

A special charge (6*d.* per sample) is applicable in the case of samples of grass, clover and field seeds submitted by farmers when the seeds have been purchased by them for their own sowing. Such samples must be accompanied by a statement giving the name and address of the vendor, the vendor's declaration with regard to the analysis of the seed, and a certificate that the test is not required in connection with a declaration for sale.

Agricultural Conditions.

THROUGHOUT the whole of Scotland the weather during June and July was unusually dry, while sunshine and warmth were more or less general. The spell of drought had a beneficial effect on areas that were more or less waterlogged during the earlier months of the year, and grain crops made good progress practically everywhere. The dry sunny weather facilitated hay-making, and the harvest was secured in most parts in excellent order. The growth of potato and turnip crops was, however, checked to some extent. During the greater part of August also the weather proved advantageous for the cereal crops, which matured rapidly, but during the last eight or nine days of the month rain was frequent in most districts and in some cases the heavier grain crops, particularly lea oats, were lodged, while ripening was retarded. The rains, however, improved the prospects of the potato and root crops and helped to restore pastures, which in many parts had become rather bare and dry.

Wheat made steady progress throughout the summer months, and towards the end of July was ripening quickly; generally speaking the ears have filled satisfactorily and straw is strong and clean. In most counties in which the crop is extensively grown rapid progress was made with cutting during August, and in a few cases considerable quantities had been stacked at the end of the month. Taking the country as a whole the yield per acre promised to be unusually good, the only districts in which it was expected that the crop would be below the average being Berwick, South-East and South-West Perth.

The barley crop was generally healthy and fairly vigorous; in some districts straw was stated to be rather short, growth having been checked by drought. Harvest began as early as 12th August in Banff and Kincardine, while in Berwick, the Lothians, North-East Fife and North-East Forfar work was started between the 15th and 18th of the month, and in the northern counties and most parts of Aberdeen and Perth between the 24th and 28th. The crop has bulked well in the northern, north-eastern and east central counties and average yields or over are looked for, but in the Lothians and Roxburgh it is expected that the yield will prove lighter than usual. In Stirling, North-West Lanark, South Ayr and Dumfries also the estimated yield is below the normal, but in these districts the acreage under barley is comparatively small. Bere was stated to be looking well, and in all districts where the crop is grown average yields or over were expected. At the end of August cutting had commenced on the mainland and in Orkney, Lewis, Harris and Kintyre, while in Shetland and Uist a start was made about 7th September.

The reports on oats were on the whole less favourable than those on wheat and barley. On good deep land the crop had a healthy appearance, but on stiff soils and on fields that were badly affected by grub it was rather patchy, while in many parts straw was deficient. In most of the northern and north-eastern counties and in Kincardine, North-East Forfar, Central and North and East Perth average yields or over were anticipated, but in the western and south-western districts the estimated deficiency in the yield

ranges from 5 to 25 per cent. In the Lothians, Berwick, Roxburgh and Selkirk the crop was stated to vary from good to very poor. Cutting was in progress under favourable conditions in all districts of the mainland during August, with the exception of North-West and South-West Aberdeen, Caithness and North Argyll. In the western islands and in Orkney, harvest was expected to begin about 7th September and in Shetland about the 12th.

Beans were reported to be vigorous and healthy and to have podded well; in practically every district in which they are grown to any extent, the yield was expected to be a full average. Little or no cutting had taken place at the end of August.

Potatoes have come on well and the prospects of the crop are very promising. Complaints of disease were received from North-East Banff, North-East Aberdeen and Uist, while "blackleg" was stated to be rather prevalent in Central Perth; elsewhere, however, the crop was reported to be vigorous and healthy. Estimates of the probable yield indicate that an average yield or over is looked for in the majority of cases, the only districts in which the produce of the crop was expected to be deficient being Central and South-East Perth, Dumbarton, Lanark and Ayr; in South Ayr, where lifting is completed except for small lots of late varieties, the yield is smaller than usual by 25 per cent.

The reports on turnips and swedes are varied. Early sown fields brairded well and have continued to make satisfactory progress, but in late sown areas the seed germinated badly and throughout the season growth has been slow, while on strong land the crop is rather indifferent. The bulbs are, however, comparatively free from disease, the only districts in which signs of "finger-and-toe" are in evidence being Moray, North-East Aberdeen and Shetland. Average yields or over are looked for in Moray, Banff, South-West Perth, Sutherland, Inverness, Nairn, Argyll, Renfrew, Dumfries, Orkney and Shetland. In the remaining districts it is estimated that there will be a shortage in the yield ranging from 5 to 10 per cent., while in Berwick the deficiency is given as 40 per cent. and in Stirling and South-East Perth 20 per cent. Mangolds are generally reported to be looking well, and in most districts in which the crop is grown a full average yield is expected.

Strawberries and raspberries are stated to have given good yields in Perthshire, but in Lanark the strawberry crop was considerably below the average owing to drought. Currants and gooseberries were full crops of good quality in Lanark, Central Aberdeen and North-East Forfar, but in South-East Perth and Dumfries they did not develop satisfactorily and the ultimate yield was below the normal. Apples, pears and plums are stated to be indifferent crops in South-East Perth, North-East Fife and Dumfries, while in South-East Lanark orchard fruits are practically a failure.

Pastures became rather bare during June and July owing to lack of moisture, but in most districts they showed a considerable improvement in condition during the latter half of August. Grazing cattle did fairly well, especially where fields were not overstocked and where the water supply was good, but in a few cases progress was slower than usual owing to poor pasturage. Dairy

cows were reported at the end of August to be in fair condition and on the whole have milked well, although in several districts the yield of milk fell off rather early owing to the scarcity of grass. Sheep on arable farms have thriven well and lambs have been sent to the markets in good condition. The reports on hill sheep are also satisfactory.

The dry summer has been favourable for bees. Stocks generally are strong and healthy, but disease is still present in Central Perth and to a small extent in South-West and Central Aberdeen. In most districts the yield of clover honey has been unusually good, while the prospects for heather honey are also encouraging.

The demand for extra labour for harvesting this year is less than usual, and except in Sutherland, Skye and some parts of Aberdeen the supply of casual workers is sufficient for requirements.

Agricultural Returns, 1925.

THE Preliminary Statement of the Agricultural Returns taken in Scotland on 4th June 1925 shows that the total area under crops and grass amounts to 4,705,500 acres, comprising 3,235,000 acres of arable land and 1,470,000 acres under permanent grass. The total acreage is the smallest recorded since 1878, while the area of arable land is the smallest since 1866, being less than in 1924 by 37,600 acres. The area under permanent grass has, however, increased by 27,800 acres, the diminution in the total area under crops and grass being thus 9800 acres.

The area under rotation grasses and clover, 1,504,000 acres, has decreased by 11,100 acres, while the area under other crops is 26,500 acres less than in the previous year. The total decrease is mainly accounted for by wheat, oats, turnips and swedes, which combined show a diminution of 33,500 acres. Potatoes, barley, sugar beet and bare fallow all show increases totalling 1000 acres or over.

The area under wheat is 48,200 acres, the smallest total since 1908, and less by 1300 acres than that of 1924; that under barley, 153,000 acres, shows an increase, as compared with last year, of 1400 acres; while that under oats, 931,000 acres, is 24,500 acres less than in 1924, and is, with the exception of 1914, the smallest ever recorded. Mixed grain and peas show increases of 200 acres and 100 acres respectively, while the areas under rye and beans to be harvested as corn are smaller by 800 acres and 200 acres respectively.

Potatoes, with an area of 141,000 acres as compared with 138,300 acres in 1924, are under the average of the preceding ten years by about 8500 acres. The area under turnips and swedes, 398,000 acres, is less than last year by 7700 acres and is the smallest recorded since 1918. Mangolds and cabbage show small decreases, while the areas under rape and small fruit are somewhat greater. Sugar beet, which increased from 4 acres in 1923 to 196 acres in 1924, now shows a total area of about 1500 acres. Of the crops not separately shown in the accompanying table, the most

notable is flax, which has increased from 126 acres in 1924 to over 700 acres this year, thus fully recovering the decrease in area that took place in the previous year.

Of the whole area under permanent grass, 159,000 acres were cut for hay and 1,311,000 acres were grazed, while of the area under rotation grasses and clover 406,000 acres were cut for hay and 1,098,000 acres were grazed. Permanent grass for mowing was greater than in 1924 by 4200 acres, but the area under rotation grass for mowing was 9300 acres less than in the preceding year; the total area cut for hay is thus smaller by 5100 acres.

The live stock returns show that horses and pigs have diminished in number, while cattle and sheep have increased.

Horses used for agricultural purposes, numbering 136,300, are fewer by 1000, the total being the smallest since 1917. Unbroken horses of one year and above are fewer by 4500 or 16·4 per cent., and foals by 500 or 7·8 per cent. The numbers of foals have decreased regularly since 1920, the total then being 14,792 as compared with 5900 in 1925. The total decrease in horses is 7400 or 3·8 per cent.

The total number of cattle, 1,197,700, shows an increase of 33,300 or 2·9 per cent The numbers of cows in milk and bulls being used for service are less than in 1924, but all other classes show increased totals. The decrease of 3600 in cows in milk is more than balanced by a total increase of 5400 in calving cows and heifers. Feeding cattle over 2 years old are more numerous by 17,200, and yearling feeding cattle and calves by 11,100 and 3400 respectively.

Ewes, which number 3,041,300, show the highest total recorded since 1908, and are more numerous than last year by 49,200. The number of lambs, 2,882,400, is about the same as in 1914 and is 59,500 greater than in 1924. Rams and other sheep one year and above show increases of 2500 and 56,000 respectively, and the combined total approximately equals the decennial average. Sheep of all classes number 7,053,400, or 167,200 more than last year. The increase since 1920 amounts to nearly 700,000 and the total is the highest since 1916.

All classes of pigs show decreases. Sows are less numerous by 6400, boars by 500 and other pigs by 29,400, the total pig population being 162,500 as compared with the record high figure of 198,800 in 1924.

It should be noted that the figures given above and in the following tables are subject to revision.

CROPS AND GRASS.

Distribution.	1925.	1924.	Increase.		Decrease.	
	Acres	*Acres*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
Total Area (excluding Water) .	**19,069,683**	19,069,683	.	.	..	..
Total Acreage under all Crops and Grass (*a*)	**4,705,500**	4,715,300			9,800	0·2
Arable Land	**3,235,500**	3,273,100		.	37,600	1·1
Permanent Grass (*a*) — For Hay	**159,000**	154,800	4,200	2·7		..
Permanent Grass (*a*) — Not for Hay	**1,311,000**	1,287,400	23,600	1·8		.
Permanent Grass (*a*) — Total	**1,470,000**	1,442,200	27,800	1·9		
Wheat . .	**48,200**	49,500			1,300	2·6
Barley (including Bere)	**153,000**	151,600	1,400	0·9		.
Oats . .	**931,000**	955,500			24,500	2·6
Mixed Grain	**1,500**	1,300	200	15·4	.	..
Rye	**5,800**	6,600	.		800	12·1
Beans (to be harvested as Corn)	**3,500**	3,700			200	5·4
Peas	**600**	500	100	20·0		.
Potatoes ..	**141,000**	138,300	2,700	2·0		
Turnips and Swedes . . .	**398,000**	405,700	.		7,700	1·9
Mangolds . . .	**1,200**	1,300			100	7·7
Cabbage . . .	**4,000**	4,100	.		100	2·4
Rape	**12,400**	11,900	500	4·2		.
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	**10,600**	10,600				
Sugar Beet .. .	**1,500**	200	1,300	650·0		
Small Fruit .	**7,200**	7,000	200	2·9		
Rye-grass and other Rotation Grasses and Clover — For Hay	**406,000**	415,300			9,300	2·2
Rye-grass and other Rotation Grasses and Clover — Not for Hay	**1,098,000**	1,099,800			1,800	0·2
Rye-grass and other Rotation Grasses and Clover — Total	**1,504,000**	1,515,100			11,100	0·7
Other Crops . .	**4,000**	3,200	800	25·0	.	..
Bare Fallow .	**8,000**	7,000	1,000	14·3		..

LIVE STOCK.

	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	**136,300**	137,300	.		1,000	0·7
Unbroken Horses (including Stallions) — One year and above ..	**23,000**	27,500	.	..	4,500	16·4
Unbroken Horses (including Stallions) — Under one year .	**5,900**	6,400	.		500	7·8
Total	**165,200**	171,200			6,000	3·5
Other Horses	**21,100**	22,500		.	1,400	6·2
Total of Horses	**186,300**	193,700	.		7,400	3·8
Cows in Milk	**348,700**	352,300	..	..	3,600	1·0
Cows in Calf, but not in Milk	**49,100**	46,400	2,700	5·8		.
Heifers in Calf	**52,400**	49,700	2,700	5·4	.	.
Bulls being used for Service	**17,400**	17,600	.		200	1·1
Other Cattle :—Two Years and above	**231,800**	214,600	17,200	8·0	.	
" " One Year and under two ..	**274,500**	263,400	11,100	4·2		
" " Under one year	**223,800**	220,400	3,400	1·5		
Total of Cattle ..	**1,197,700**	1,164,400	33,300	2·9		
Ewes kept for Breeding	**3,041,300**	2,992,100	49,200	1·6		..
Rams to be used for Service in 1925	**86,400**	83,900	2,500	3·0	.	..
Other Sheep :—One year and above	**1,043,300**	987,300	56,000	5·7	..	..
" " Under one year ..	**2,882,400**	2,822,900	59,500	2·1	.	.
Total of Sheep	**7,053,400**	6,886,200	167,200	2·4	..	..
Sows kept for Breeding	**17,600**	24,000	..	..	6,400	26·7
Boars being used for Service	**2,200**	2,700	.	..	500	18·5
Other Pigs	**142,700**	172,100	.	.	29,400	17·1
Total of Pigs	**162,500**	198,800	..	..	36,300	18·3

(*a*) Excluding Mountain and Heath Land used for grazing (9,559,000 acres in 1925, as compared with 9,672,800 acres in 1924).

RECENT PERIODICAL LITERATURE.

A number of the following extracts and summaries are taken from recent bulletins of the International Institute of Agriculture. Full references to the bulletins and to the original publications quoted therein may be obtained on application to the Secretary, Board of Agriculture for Scotland, York Buildings, Edinburgh.

The Shape and Weight of Eggs in Relation to the Sex of Chicks. *Jull, M. A., and Quinn, J. P. Journal of Agricultural Research, Vol. XXIX., No.* 4. *Washington, D.C.*, 1924.—In order to determine the relation between the form of the egg and the sex of the chick, the length and maximum breadth of each of 990 eggs laid by 24 Barred Plymouth Rock pullets between the middle of February and the end of April were measured at the time of laying. The sex of the chicks was determined by dissection at hatching time.

The results are summarised as follows:—

There is no correlation between the absolute length of an egg and the sex of the chick hatched from it.

There is no correlation between the shape of an egg and the sex of the chick hatched from it.

There is no correlation between the weight of an egg and the sex of the chick hatched from it.

The Preservation of Shelled Eggs. *Coudis, C. H., La Hacienda, Vol. XIX., No.* 11. *Buffalo, N.Y., U.S.A.*, 1924.—The author considers that about 20,000 million eggs are produced annually in North America, of which many are spoilt in transport, through exposure to the weather and the treatment they undergo before consumption. The author then mentions the great value of this "complete food," owing to its content in protein, vitamines, fats and mineral salts.

Dr. M. E. Pennington (of the Food Research Laboratory) was appointed by the United States Government to carry out investigations for the purpose of avoiding this loss, and concluded, from experiments made by Titman, that the best means of preserving eggs was to shell them while fresh and keep them in cold storage.

This process is being developed on a large scale by Titman at Boston. Large quantities of fresh eggs are received daily, especially in spring and summer. They are all examined with special ovoscopes by means of which it can be ascertained whether they are good or not. Those rejected are sent through tubes to the lower floor of the building. The good eggs are sent to the shelling room, which is kept at a temperature of 19°C. Each operator shells 6000 eggs daily; the factory can prepare and pack 500,000 daily. As soon as the shell is broken, the contents are poured into antiseptic basins, again examined, and all those which are unsound are rejected, and the remainder are poured together into receptacles, which, as they are filled, are sent to an electric mixer. A uniform and homogenous liquid is formed and poured into 30-lb. tins, which are immediately sent to the refrigerating rooms, where they are kept at a temperature of 22°C. The installation of the establishment is supplied with all kinds of disinfectant material, refrigerator wagons, elevators, etc.

Austria. Order in regard to Diseases of Bees.—This order has reference to the Austrian Law of 6th August 1909 (*Reichsgesetzblatt* 177) on infectious diseases in animals, and in respect of bees makes compulsory the notification of brood diseases, of the appearance of *Nosema apis* in the epidemic form and of acaries. In any sporadic appearance of these diseases, the mayor must forbid any transport whatever of the hives affected, and must secure the destruction of diseased combs. Should there be a more general outbreak, the veterinary officers and a beekeeping expert must be called in, who, if necessary, will order the destruction of the bees attacked by the disease, and the removal, with due precautions and in the evening, of the respective combs. If the owner of the hive refuses to comply with these orders, he may be compelled to take measures to ensure that the bees do not leave the hive. The infected hives from which the bees have been removed must be burnt or at least cleansed and disinfected as far as possible.

Swarms may not be taken from suspected apiaries, unless they have been ascertained to be perfectly healthy. The epidemic is declared to be at an end when after two months' application of all the necessary prophylactic and disinfecting measures it is found that there are no further cases even of suspected disease.

The order concludes with a detailed account of the symptoms and nature of the diseases mentioned.

France: The Cinema for Agricultural Use.—By a Decree published in the *Journal Officiel* of 16th November 1924, a permanent Committee of 33 members is set up, which is attached to the Ministry of Agriculture and decides on the grants to be made for the preparation and purchase of films, for the installation and working, in the rural communes and in the institutions for instruction in agriculture, of cinematographic apparatus, whether fixed or travelling, intended for the diffusion of information useful to farmers and for the necessary propaganda.

Protection of the natural features of Lower Austria.—By a law of 3rd July 1924, the preservation of natural features, whether characteristic or unusual, is assured alike on economic, educational and, in respect of the landscape, æsthetic grounds. Since watercourses, lakes, nests of birds of prey, single trees or groups of trees may be declared to be natural features, and in this way the right of the respective owners to dispose as they please of their property is curtailed, the law affects agricultural interests very closely. Thus by paragraph 9 the State authority does not allow owners, tenants or holders in usufruct to modify or destroy the natural features, unless they are of a kind to endanger human life. The owner, tenant or holder in usufruct have the right of appeal to the President of the State ("Landeshauptmann" of Lower Austria) against the refusal to authorise modifications of natural features, and such refusal may, moreover, only be pronounced after considering the report of the regional Chamber of Agriculture, which is the representative of the agricultural interests. Article 10 pronounces it to be the duty of the authorities to take special care to preserve existing natural features, employing every kind of administrative procedure culminating in legislative measures relating to waters, forests, buildings, etc., and even setting aside funds for the purpose. If the demand for the work required does not issue from the owner but from the special Office for the Preservation of Natural Features, this Office must be responsible for the expenditure.

If the owner of any natural feature does anything to alter or destroy it, he may be compelled to restore it as far as possible to its original state. With the object of preserving the landscape, the consent of the special National Office for the Preservation of Natural Features is required for the clearing of forest, as well as the consent of the competent forestry authority. No rare trees or bushes may be cut down, nor may rare flowers or plants be gathered for commercial purposes, nor rare animals taken or killed. The President of the State (province) may declare districts, which are rich in natural features, to be reserves, after, however, obtaining the consent of the respective owner.—(*Die No.* 8 *Landeskulturgesetze, Vol.* I. *Vienna*, 1924. *Publication of the Lower Austrian Chamber of Agriculture.*)

United States: Report on the International Dairy Congress, October 1923.—This report has been published by the United States Department of Agriculture, Washington. For 20 years past successive International Dairy Congresses have been held in different European countries. The first was the Brussels Congress in October 1903, at which the International Dairy Federation was founded. There followed in order, the Paris Congress in 1905, a Congress at the Hague in 1907, at Budapest in 1909, at Stockholm in 1911, and at Berne in 1919. During the period of the War the Congresses were suspended, and it was not till 1923 that a series again took place, namely, at Washington, 2nd to 12th October, at Philadelphia, 4th October, and at Syracuse, N.Y., 5th to 10th October. The last Congress was organised by the "World Dairy Congress" in pursuance of the authority given by a Law of the United States Parliament, dated 3rd March 1921. The co-operation of the American Government was secured through the Department of Agriculture as well as through the other Ministries, and the Congress was organised by agreement with the

Federation Internationale de Laiterie and with the co-operation of the national and local organisations of the United States.

As already stated, conferences took place in succession at Washington, Philadelphia and Syracuse, where an International Dairy Exhibition was also held, including select breeds of dairy cattle acclimatised in the United States, dairy industry products, butter, cheese, condensed milk, etc., and all the equipment used in the industry itself. The programme of the Congress was comprehensive and discussions took place on all the questions relating to the object of the Congress, which was defined in the official programme as the establishment of an International exchange of recently acquired knowledge, both scientific and practical, relating to the dairy industry, and also the issue of a statement on the methods and results of the various ways of using milk and its derivatives for human food. The report contains *in extenso* the communications made by a number of scientific experts in each of the 27 sections into which the Congress was divided. The international trade in milk, the increase of the milk yield in the United States, the working of the Regional Milk Council System in the United States, the employment of condensed milk and milk powder in human food, the milk supply of towns, questions relating to cheese-making, methods of technical instruction for the staff of dairies, the food value of milk, ice creams, methods of improving the food uses of milk, dairy instruction in various countries, the education of the consumer and co-operation methods, milk tests, milk transport, inspection of dairy products, feeding of dairy cows, the chemistry and bacteriology of milk, dairy equipment, scientific study of milk and milk powder, breeding of dairy cattle and their diseases—the above is a list of the subjects treated in the different sections of the Congress.

The Congress did not pass any resolution on the subject of international relations which are not as yet completely established. Besides the meetings a number of excursions were organised, enabling the members of the Congress to visit dairies, pasturage centres, laboratories, model farms, experimental institutes, etc.

In conclusion, while the report may be said to form a complete encyclopædia on the subject of milk, the object which has been specially kept in view is to emphasise the influence of economic problems of international trade and consumption of dairy products; prophylactic methods of dealing with live stock diseases and supervision of the sanitary conditions under which stock is kept; the standardisation of products, the effect of the consumption of milk and milk products on the general health and the importance of such consumption on the physical and intellectual development of the people.—(*Proceedings of the World's Dairy Congress, Washington, D.C., October*, 2, 3; *Philadelphia, Pa., October*, 4; *Syracuse, N.Y., October*, 5, 6, 8, 9, 10; 2 *vol. in* 8*vo., p. XVI.* + 1599. *Washington, D.C.*, 1924.)

Experiments in Acclimatising Scotch Potatoes in Austria. *Haunalter, Emil, Oesterreichische Zeitschrift für Kartoffelbau, Part* I. 31*st March* 1924.—In 1921 Austria was almost entirely without seed potatoes, and a delivery of 6000 loads of Scotch potatoes was made by England in the form of a loan for production, thereby making the cultivation of potatoes once more possible in Austria. It was also expected that by this means a regeneration on a large scale of Austrian potato cultivation might be effected. While the original object of the re-establishment of potato production was successfully achieved, the latter attempt ended in failure. The imported kinds included Up-to-Date, King George, Edzell Blue, Arran Comrade, Arran Victory, etc., and with the exception of Up-to-Date, which had been grown in Austria for ten years past, degenerated so completely that scarcely any seed potatoes of these varieties were obtainable. An official enquiry showed that they had for the most part lost their productivity, a proof of the fact that in the case of potatoes, any considerable changes in the conditions under which they are grown are followed by deterioration in their yielding capacity. The Up-to-Date variety is still grown.

Relations between the Agricultural Value of Meadow Grasses and their Anatomical Structure. *Schindler, H., Zeitschrift für das landwirtschaftlichen Versuchswese in Deutschösterreich*, I *vol.* 8*vo. Vienna*, 1923.—The author investigated the microscopical structure of meadow grasses in order to find an explanation of their varying agricultural value. It was found that

the morphological and anatomical characteristics (size and subdivision of the vascular bundles, structure of the leaf epidermis and also the indentation of the edges) can furnish the clue to the differences in the value of such grasses as cattle feeds.

On these characteristics he bases a system of classification of grasses whether good or bad, and examines the question as to why the number of "noble" grasses has been reduced, and then studies the estimation of the value of grasses also from the chemical and biological point of view, in connection with the digestion of cellulose.

It was found that the cell walls of grasses can be digested in the stomach of herbivorous animals when the cell walls are not lignified or cutinised. In judging the value of a meadow grass, therefore, it is essential to examine the development of the vascular bundles and the thickening of the cuticle.

A Comparison of Atmospheric-Nitrogen Fertilizers. *Allison, R. V., Soil Science, Vol. XVIII., No. 5. Baltimore, Md*, 1924.—The atmospheric-nitrogen fertiliser industry has spread greatly especially after the war, in consequence of which a practical comparative investigation as to the efficacy of these fertilisers as compared with the nitrogen fertilisers which have been in use for some time (nitrate of soda and sulphate of ammonia) has become necessary. The author's tests lasted three years and were made especially with cotton, maize and tobacco.

Nitrate of ammonia.—This gave results quite equal to those of the substances with which it was compared in the tests. It is readily available and has no abnormal effects. The greatest objection to its use is the facility with which it absorbs moisture, rendering it sometimes unusable for fertiliser mixtures. This drawback can be obviated by preparing it in a granulated form and oiling, or converting it into double or mixed salts.

Double salt of nitrate and sulphate of ammonia.—This produces the same effect as the single salts; the fertiliser is less hygroscopic than the nitrate salt of ammonia.

Double salts obtained from nitrate of ammonia with chloride or sulphate of potassium.—The above remarks also apply to this fertiliser.

Phosphate and superphosphate of ammonia.—These are excellent sources of nitrogen, promote growth and give a satisfactory yield. The large amount of phosphorus partially masks the effect of the nitrogen.

Ammonium chloride.—This is readily available, but in some cases when applied in quantities of 40-60 lb. per acre has had a toxic effect, probably due to an excess of chloride ion.

Urea.—Similar in its effects to the other substances and has the advantage of being physically an excellent substance, which, in addition, leaves no basic or acid residues. It seems therefore to be the ideal nitrogen fertiliser.

Urephos.—Gives varying results; it has been used only to a limited extent and no definite conclusions can be drawn.

Cyanamid.—Gave less satisfactory results than the other fertilisers, mostly because too many factors, both in the soil and the fertilising mixtures, influence its decomposition. Results are poor when applied together with acid phosphates, this being probably due to the transformation of a part of the cyanamid nitrogen into dicyanamid, a compound which not only cannot be utilised as a source of nitrogen, but which is decidedly toxic to some plants and to nitrifying bacteria.

If applied separately from the phosphates it gives good results, especially when phosphate of lime or basic slag are used as a source of phosphorus.

Cyanamid gives different results with different crops, being satisfactory for maize, and not so for cotton, probably because the latter requires nitrogen as a nitrate, whereas maize can utilise it also as ammonia. With the winter cereals, especially wheat and rye, results are in all respects similar to those obtained with the check fertilisers.

Injury caused to Plants by Mixing Sawdust with the Soil. *Soederbaum, H. G., and Barthel, Chr. Medd.* 271 *fran Centralanstalten för försöksväsendet pa jordbruksomradet.*—During the war, sawdust was generally used as a stable-litter; it is still so used to a great extent in the sawmill districts of Sweden.

The authors show that arrest in plant growth took place through applying sawdust to sandy soil, 2 per cent. of cellulose completely stopping the nitrification of an otherwise normally nitrifying soil. This stoppage was of long dura-

tion. It is not caused by resins or similar substances, but is more probably due to the capacity of cellulose compounds to use up the nitrates.

If the cellulose in the soil is destroyed nitrification is resumed.

The arrested growth phenomena can be eliminated by the use of a nitrate fertiliser.

Effects of Lime on Decomposition of Soil Organic Matter. *White, J. W., and Holden, F. J., Soil Science, Vol. XVIII., No.* 3. *Baltimore, Md.*, 1924. —The experience of forty years shows that there are no fundamental differences between the action of quicklime and that of crushed limestone on soil organic matter. Both substances, applied in quantities eight times greater than that used for calcareous soils, gave a considerable increase in nitrogen over that in soils not treated. There is no sign whatever of any destruction of organic matter by the quicklime, as might have been feared. Indeed there is a greater preservation of nitrogen and organic matter with lime (in the form of quicklime or limestone) than in soil not treated.

Influence of Diet and Sunlight on the Vitamine Content of Milk. *Luce, E. M., The Biochemical Journal, Vol. XVIII., Nos.* 3-4. *Cambridge*, 1924.—The milk from the same cow is subject to remarkable variations as regards its anti-rachitic and growth-promoting properties.

The cow's diet is probably the main factor in determining the growth-producing value. When the cow has a diet of green fodder the milk possesses a growth-promoting value much larger than if fed on dry feed, deficient in fat-soluble vitamines. These results are the same whether the cow is kept in sunlight or in a dark cowshed, and it would therefore seem that no conclusions as to the action or otherwise of light can be drawn from these experiments.

The anti-rachitic properties depend on the diet of the cow, and probably on the degree of illumination to which it is exposed.

The milk of cows, kept in open pasture, has a marked and high anti-rachitic value, while if the animal is kept in a dark cowshed it yields a milk much inferior from the point of view of its effect on rachitic conditions.

It is not improbable that the seasonal incidence of rickets among children has a definite relation to these facts, in so far as the milk would have a higher anti-rachitic value in summer than in winter.

Effect of Feeding Cabbage and Potatoes on Flavour and Odour of Milk. *Babcock, C. J., United States Department of Agriculture, Department Bulletin No.* 1297. *Washington, D.C.*, 1924.—Results of tests made by the Bureau of Dairying at the Experimental Farm at Beltsville, Md., in order to determine: (*a*) If cabbage and potato feeds affect the flavour and odour of milk; (*b*) how to distribute these feeds and treat the milk in order if possible to reduce the effect on the milk to a minimum.

In the tests the author used six Holstein and ten Jersey cows.

The animals received as a maintenance ration, in quantities varying according to the quantity of milk produced, the following mixture: maize gluten 100 kg., bran 100 kg., oats 100 kg., linseed cake 50 kg., cotton cake 50 kg., and in addition, as much as the animals would take of lucern hay.

The cows were divided into groups of 4:—

1st group: maintenance ration + hay (check).

2nd group: maintenance ration + hay + 15 lb. of cabbage or potatoes fed 1 hour before milking.

3rd group: maintenance ration + hay + 30 lb. of cabbage or potatoes fed 1 hour before milking.

4th group: the same as the 3rd group, fed immediately after milking.

Samples of milk were taken from each cow during milking; the milk was cooled but not ærated.

In order to judge of the effect of æration on the flavour and odour of the milk produced by a cow fed as above, samples were also taken of the milk after it had been allowed to run over a surface refrigerator.

These tests gave the following results:

The consumption of 14·3 lb. of cabbage 1 hour before milking causes a disagreeable odour and flavour in the milk. If the quantity consumed is in-

creased from 14·3 to 24 lb. on an average, the odour and flavour of the milk are considerably intensified.

If the animal consumes 25 lb. of cabbage immediately after milking, the milk has a disagreeable odour and flavour.

Suitable æration considerably decreases the odour and flavour imparted to the milk by the cabbages and suffices to eliminate a slight odour and flavour developed before æration.

The flavour and odour caused by cabbages are slightly less pronounced in cream than in milk.

A consumption of 14·8 lbs. of potatoes 1 hour before milking causes a very slight abnormal odour and flavour, rarely noticeable in the case of most animals. If the quantity be increased from 14·8 to 29·8 lb. the flavour and odour of the milk are not accentuated; 28·7 lb. of potatoes immediately after milking has no effect on the flavour and odour of the milk.

Cause and Prevention of Disagreeable Flavours of Butter.—*Gibson, A. L., Scientific Agriculture, Vol V., No. 2. Ottawa, Ontario*, 1924.—The author has ascertained that the tallowy flavour of butter is due to oxidation, which oxidises not only olein, but also the glycerol produced by hydrolysis of the fatty matter.

The oxidation of glycerol produces glycolic acid.

It should be stated that:—

(1) exposing cream and butter to the simultaneous action of the air, light and a high temperature, favours oxidation;

(2) lactose in a neutral or slightly alkaline medium is highly favourable to oxidation;

(3) butter made under good conditions, with fresh cream at a reasonable degree of acidity, cannot acquire the tallowy flavour through the presence of lactose, as lactic acid acts as a slight preservative;

(4) copper and its alloys, bronze and nickel, as also the salts of these metals acting on butter in consequence of the excess of acidity in the cream, act as catalytic agents of oxidation. Iron and its compounds favour oxidation in the same way, but their action is weaker;

(5) abnormal alkalinity of cream or butter increases the oxidation;

(6) casein, in combination with copper and its salts, but not alone, facilitates the production of the tallowy flavour and is the cause of the pink or brownish colour in the last stages of development.

The conditions which favour or give rise to a fishy flavour of butter are:—

(1) high acidity of the cream;

(2) high salt content of butter;

(3) excessive churning of the butter, which increases the air content of the butter;

(4) the presence of salts of iron and copper, which act as catalysers in the oxidation of the choline.

Butter made with pasteurised cream does not so quickly assume the fishy flavour.

The preventive measures against these flavours, which depreciate the market price of butter, are:

(1) the use of fresh cream in making butter;

(2) the avoidance of completing the process of manufacture by using chemical or other substances; neutralisers are useless if fresh cream is used:

(3) the pasteurisation of the cream, and if it is desired to obtain a certain degree of acidity, treatment with pure cultures;

(4) care not to bring the cream into contact with badly-tinned or copper receptacles;

(5) the avoidance of excessive salting;

(6) the avoidance of excessive churning;

(7) the utmost cleanliness.

The Green-fly Pests of Market Garden Crops. *F. V. Theobald in Jour. Roy. Horticultural Soc*, 1925.—The number and variety of the green-fly pests of vegetables and market garden crops is amazing. Not only has each type of vegetation numerous kinds of green-flies, lettuces and carrots have each five distinct species, beans and potatoes four, and so on, but each pest prefers its own vegetable almost to the exclusion of others. Not all of these pests is

of great importance, for some are rather rare insects, and some are only of occasional or local significance, but some are more or less general pests which gardeners and market growers cannot afford to ignore. Mr. Theobald, in this useful paper, discusses the habits and harmfulness as well as the control treatment necessary for the aphides of peas and beans, potatoes, carrots, brassicas, lettuces, celery, cucumbers and their kind, artichokes, beetroot and spinach. A number of clear photographs and drawings help in the identification of species. The habits and the control measures necessary for the different species vary greatly, and for detailed information about these readers should consult the paper.

The Activities of the Honey-bee. *A. E. Lundie, U.S. Dept. Agr., Dept. Bull. No.* 1328, 1925.—Much is known regarding the activities of the hive-bee, yet by the aid of an ingenious piece of apparatus Mr. Lundie has been able to add still more. The essence of the apparatus was that it compelled the bees of a hive to depart by one fixed opening and to return by another, and the opening with its passage was so arranged that the weight of the passing bee caused an electric contact to be made, which, being recorded, gave a count of the daily goings and comings of the inhabitants. This detailed computation led to results which could not easily be obtained by simple observation. It was found, for example, that apart from weather the activity of the hive bore a close relation to the honey flow of flowering plants. A hive from which 10,000 to 20,000 exits were being made in late April, livened up as the nectar increased, so that when the honey flow was at its height in the third week of May, the exits numbered 60,000 to 70,000.

Many weather conditions have an adverse effect on bee activity, as everybody knows; but Mr. Lundie has in some sort measured the effects. A threatening storm, of but an hour's duration, reduced the possible flight on one day in the honey flow by 7·41 to 9·67 per cent. A wind, with a velocity varying from 16 to 21 miles per hour and lasting from 9 a.m. till 6 p.m., reduced the possible maximum flight by more than one quarter (28·53 per cent.). Low temperature has the same kind of effect. Even during the enticements of the honey flow bees did not begin to leave the hive till the temperature of the outside air registered 14°–16°C., and the mass of bees refused to budge till 16°–18°C. were reached; that was somewhere between 9 and 11 a.m. A combination of adverse weather factors may be so potent as to reduce the departures to a fraction of 1 per cent. of the possible.

Another interesting fact brought out by the door statistics was that even when nectar is plentiful bees do not rush to the flower, slowly gather the sweet, and then, rushing back to the hive, deposit it rapidly and make for the flowers again. The process, in spite of the appearance of bustle, is more leisurely than might be supposed. In a single day the range of time covered by the trips to the flowers varied from 15 minutes to 1 hour 43 minutes, and, what is more surprising, the length of time spent within the hive between journeys is greater than the time spent on the journeys themselves. On any day the morning and evening trips were shorter than those between times.

As to the work done by the bees. The simple device of having his hive permanently placed on a balance enabled Mr. Lundie to measure the amount added to the weight of the hive each day, and this, compared with the number of visits of the bees, enabled some valuable deductions to be drawn. At the height of the flowering season the bees made their record score, for on May 11th, when 59,658 exits were made, they added 1440 grams (3·168 lbs.) to the weight of the hive. But on May 22nd they worked harder at collecting, for the load of each returning bee was greater, the average of each of the 44,597 bees being 25·3 millegrams, or almost nine-tenths of an ounce for each 1000 bees. The real load carried by each bee would be somewhat heavier than these figures indicate, for the method of weighing the daily additions to the hive made no allowance for the daily loss of weight through evaporation and consumption of honey already gathered.

Lastly, something was learned about the duration of life of the bee. During the eighty-nine days of the experiment, 2,434,666 bees left the hive, and of these 3·16 per cent. found death at their work. This means that, on an average, each bee makes 31·65 trips before it dies. But deaths in the hive also occurred; 65,178 bees were lost from all causes, and of these it can be said that 1·63 per cent. died in their beds.

Recovery of Oats after Frit-fly Attack. *N. Cunliffe in Ann. Applied Biology, vol. XII. Cambridge,* 1925.—It has been deduced from results following frit-fly attack that the variety of oat which tillered best made the best recovery and best show at harvest. In order to test by experiment what truth lay in the statement, the author simulated the attack of frit-fly in covered experimental plots containing seedlings of two distinct varieties of oats. A poor tillerer and a prolific tillerer, "Sir John Haig" and "Scots Potato" respectively, were chosen. When the plants of these had grown sufficiently, the growing point in each was removed by a fine needle, so that the main stem withered and tillers were put out, just as in the case of frit fly attack. The more instructive of the results were as follows:—Normal undamaged *Haig* plants produced 21 per cent. fewer panicles than undamaged *Potato*, but after destruction of the main stem, as described above, *Haig* made almost a complete recovery, whereas *Potato* production of panicles was reduced by about 40 per cent. If, however, in addition to the main stem the first two tillers were killed, *Potato* and *Haig* both suffered about 40 per cent. reduction in panicles. Similar relationship was shown in the yield of grain. After the loss of the main stem *Potato* never attained to the full yield of undamaged plants, the loss in weight of grain being about 60 per cent. On the other hand *Haig* to a great certain extent recovered its yield. The effect of destroying the first two tillers, as well as the main stem, was much more serious and more equable, for in each case a loss in crop of about 80 per cent was recorded. The straw yield was very much like that of the grain. It would seem, therefore, that the tillering capacity of a variety of oats is no guide to its recovery after attack by frit fly. At any rate in the sheltered experimental plot *Haig* shows a much greater recuperative power than *Potato*, though it would be rash to conclude that exactly the same results would be obtained in the open field.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE and FEEDING STUFFS in June, July and August 1925.

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	JUNE.			JULY.			AUGUST.		
	1st.	2nd.	3rd.	1st.	2nd.	3rd.	1st.	2nd.	3rd.
FAT STOCK:—									
CATTLE—	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w. s. d.	per cwt. l.w s. d.	per cwt. l.w. s. d.
Aberdeen-Angus ...	68 11	62 2	47 7	69 5	63 1	49 10	69 9	62 10	49 1
Cross-bred (Shorthorn)	64 0	58 2	43 4	64 10	58 7	43 5	65 0	58 10	43 1
Galloway	66 2	60 0	...	63 1	58 0	..	62 6	57 11	...
Ayrshire	61 6	51 6	38 0	62 0	52 0	40 0	61 3	52 0	40 0
Blue Grey	.	.	..	62 0	..	...	..	..	..
Highland .. .		...		...		...	...		...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
VEAL CALVES ...	18	12	9½	16¾	11¾	9¼	16¼	11½	8¼
SHEEP—	under 60 lb. per lb. d.	60 lb. and upw'ds per lb. d.	Ewes per lb d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.	under 60 lb. per lb. d.	60 lb. and upw'ds. per lb. d.	Ewes per lb. d.
Cheviot ..	18¼	17½	14¼	17	15¾	13¼	16¼	15	12½
Half-bred ..	18¼	17¼	12¾	17	15¾	11½	15¾	14½	11
Blackface	18	16¼	13½	16½	15¼	12¼	14¾	13½	11½
Greyface	18¼	17¼	10¼	17	15¾	9½	16	14½	9¼
Down Cross	18½	17¾	...	17	16	...	15½	14¾	...
PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	12 10	11 6	9 0	12 6	11 1	...	12 7	11 3	.
Porkers	13 2	11 11	9 0	12 8	11 6	...	12 10	11 7	...

AVERAGE PRICES OF LIVE STOCK IN SCOTLAND—*continued.*

Description.	June. 1st.	June. 2nd.	June. 3rd.	July. 1st.	July. 2nd.	July. 3rd.	August. 1st.	August. 2nd.	August. 3rd.
STORE STOCK:—									
STORE CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head	Per head	Per head.
Aberdeen-Angus:	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	21 1	16 9	12 12	19 15	16 7	13 10	20 5	17 4	14 18
Two-year-olds ...	26 10	22 4	17 10	26 2	21 1	17 15	25 18	21 18	...
Cross-bred (Shorthorn):									
Yearlings	19 8	15 6	12 12	18 6	14 11	12 0	17 13	15 1	12 10
Two-year-olds ...	25 0	20 7	16 19	24 4	19 2	16 9	24 9	18 17	16 10
Galloway:									
Yearlings	16 9	...	...	17 1	...	...	..	13 5	...
Two-year-olds ..	29 15	20 10		24 10	.	.	...	20 0	...
Ayrshire:									
Yearlings	12 1	10 10	..	12 3	11 10	.	...	10 0	..
Two-year-olds ..	.	.		16 10	13 10		.	...	...
Blue Grey:									
Yearlings	17 15	..	.	..	.	..	...	.	..
Two-year-olds .		...	.	...	.	..	..	...	...
Highland:									
Yearlings	14 3	11 19	9 14	11 19	10 10	9 5	...	..	..
Two-year-olds ...	18 8	15 18	14 0	16 3	14 15	13 2	...	.	..
Three-year-olds .	23 18	19 8	17 10	19 10	15 18	14 10	...	..	...
DAIRY COWS—									
Ayrshire:									
In Milk	31 11	22 10	13 13	32 10	24 6	14 6	32 15	25 1	15 4
Calvers	31 1	23 13	15 3	32 11	24 10	15 11	33 17	25 15	16 17
Shorthorn Crosses:									
In Milk	36 13	27 5	19 4	37 13	29 0	20 6	37 19	29 0	21 3
Calvers	35 9	26 7	18 2	36 16	27 9	18 11	38 10	29 3	20 4
STORE SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	64 1	51 10	41 8	...	50 3	..	...	...	...
Half-bred Hoggs ...	86 7	71 11	55 5	..	...	..	...	...	...
Blackface Hoggs ...	52 1	41 5	30 9	41 6	34 10	...	42 6	...	...
Greyface Hoggs ...	65 1	54 11	46 9	61 0	52 6	45 8	57 3	56 4	41 0
Down Cross Hoggs	...	...	...	...	...	...	..	...	..
STORE PIGS—									
(6 to 10 weeks old)	42 10	28 2	...	43 8	28 6	...	38 5	25 5	...

AVERAGE PRICES OF DEAD MEAT AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	Quality.	June.			July.			August.		
		Dundee	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
BEEF:—		per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
Home-fed—										
Bullock or Heifer ...	1	10	10½	11½	10	10⅜	11¼	10	10¾	11⅜
	2	9¾	10⅛	10⅜	9¾	9⅞	10½	9¾	10	10⅛
Bull . . .	1	8½	8¾	8½	8½	9⅜	8⅜	8½	9½	8½
	2	8	8⅜	7⅜	8	8½	7⅜	8	9	7⅝
Cow	1	7	6¾	8⅜	7⅛	6⅞	8½	7½	6⅞	8
	2	6½	6⅜	6⅞	6½	6⅜	6½	6½	...	6½
Irish—										
Bullock or Heifer ...	1	...	..	10¼	...	...	10½	...	...	10¼
	2	...	...	9½	...	...	9¾	...	.	9½
Bull	1	.	..	..	...	...	...	..	...	7⅞
	2	...	..	...	...	...	...	...	...	7
United States & Canadian—										
Killed at Birkenhead	1	.	...	..	...	...	...	...	...	...
	2	...	...	...	...	..	...	...	...	...
,, Glasgow .	1	...	...	10⅜	...	...	10	...	...	10
	2	...	...	9¾	...	...	9½	...	...	9½
Argentine Frozen —										
Hind Quarters	1	..	6	.	...	6½	...	...	6¾	...
	2	..	5⅝	. .	.	..	...	...	6¼	...
Fore ,, . ..	1	...	3¾	...	...	4	...	...	4⅜	.. .
	2	...	3½	..	...	3¾	...	...	...	...
Argentine Chilled —										
Hind Quarters ...	1	...	7¼	7⅜	...	8⅜	8⅜	...	8¾	8⅛
	2		7	6⅜	. .	8⅛	7½	...	8½	7⅛
Fore ,, ...	1	...	3⅞	3¾	...	4⅜	4⅜	. .	5	5
	2	...	3⅝	3⅛	...	4¼	4	...	4⅝	4⅜
New Zealand Frozen—										
Hind Quarters .	1	...	...	..	...	..	...	...	...	6½
	2	...	...	...	..	...	...	...	...	...
Fore ,, ...	1	...	...	...	...	...	...	...	...	3⅞
	2	...	...	...	...	...	...	...	...	3¾
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	17⅛	16	16⅛	16¼	15	15¼	15½	13½	13⅜
	60 lb. & over	17	15	15	...	14	14⅛	15	...	12¾
,, Cross	under 60 lb.	17⅛	16	16⅛	16¼	14¾	15¼	15½	13½	13⅝
	60 lb. & over	17	15	15	...	14	14	15	...	12⅝
Ewes, Cheviot	1	14	...	14	13¼	...	12¼	12¼	...	10⅜
	2	...	...	11½	...	..	10¼	11	...	9⅛
,, Blackface ..	1	14	...	14	13¼	...	11¾	12¼	..	9⅝
	2	...	...	11½	...	...	9¼	11	...	8
,, Cross	1	10	10⅝	10⅝	10	9½	9⅝	8¾	8⅞	8⅞
	2	9	9⅞	9¾	9	...	8⅝	8½	...	8⅛
Argentine Frozen ...	1	...	...	7⅛	...	...	6¾	...	...	6⅝
	2	...	...	6⅝	...	...	6½	...	...	6
Australian ,, ...	1	...	6¾	...	...	6½	...	...	6½	...
	2	...	6½	...	...	...	...	...	...	...
New Zealand ,, ...	1	...	6½	...	...	...	...	...	...	...
	2	...	...	...	...	...	...	...	...	...
LAMB:—										
Home-fed	1	...	20	18¾	17	16½	16¾	16½	14¼	14¼
	2	...	...	18	...	...	15¾	...	11	13
New Zealand Frozen ...	1	...	12⅝	11¾	...	12½	11¼	...	12¼	11⅜
	2	...	12½	11⅜	...	12	10¾	...	...	10⅜
Australian Frozen ...	1	...	...	...	...	...	..	...	...	...
	2	...	...	...	...	...	...	...	...	...
Argentine ,, ..	1	...	...	...	...	...	...	...	...	...
	2	...	...	...	...	...	...	...	...	...

AVERAGE PRICES OF PROVISIONS AT GLASGOW.

(Compiled from Reports received from the Board's Market Reporter.)

Description.	Quality.	June. s. d.	July. s. d.	August. s. d.
BUTTER:				
Irish Creamery per cwt.	1	179 9	195 2	203 3
	2	...	...	201 0
„ (Unsalted) ... „	1	186 6	200 0	209 3
Australian ... ... „	1	178 4	196 0	203 6
„ (Unsalted) „	1	180 8	...	208 0
Canadian ... ... „	1	...	193 6	197 9
Danish ... ... „	1	194 0	202 0	219 3
„ (Unsalted) ... „	1	200 0	207 10	225 0
Friesland (Unsalted)... „	1	199 4	206 5	218 6
New Zealand ... ... „	1	183 9	197 5	208 6
„ (Unsalted) „	1	191 6	204 4	214 6
Russian ... ... „	1	...	186 0	189 0
CHEESE:				
Cheddar (Old)... ... „	1	122 6	...	...
„ (New) ... „	1	95 6	108 5	118 6
Cheddar Loaf ... ... „	1	128 8	115 2	131 4
Dunlop (Old) ... ... „	1	122 0	...	...
„ (New) ... „	1	94 3	106 7	117 0
Canadian ... ... „	1	111 0	112 0	...
New Zealand (Coloured) „	1	102 0	111 10	116 0
„ (White) „	1	102 6	111 10	116 0
BACON:				
Ayrshire (Rolled) ... „	1	154 0	152 10	154 0
Irish (Green) ... ... „	1	...	142 6	150 6
„ (Dried or Smoked) „	1	158 6	156 0	161 4
„ (Long Clear) ... „	1	142 0	145 2	160 0
Wiltshire (Green) ... „	1	148 0	142 6	150 0
„ (Dried or Smoked) „	1	160 0	153 6	161 0
American, Long Clear Middles (Green) „	1	111 9	119 10	126 0
American, Short Clear Backs ... „	1	110 6	109 7	114 3
American, Sides ... „	1	105 9	109 2	114 0
„ Cumberland Cut „	1	...	...	...
Canadian, Sides ... „	1	117 0	116 7	122 9
„ Cumberland Cut „	1	108 0	112 0	...
Danish, Sides ... ... „	1	125 9	124 0	133 3

Description.	Quality.	June. s. d.	July. s. d.	August. s. d.
HAMS:				
Irish (Smoked) per cwt.	1	207 0	207 0	222 3
	2	200 0	198 0	214 9
American, Long Cut (Green) ... ... „	1	121 6	132 0	133 9
	2	...	...	...
American, Short Cut „	1	121 6	128 7	129 3
	2	...	...	...
Canadian, Long Cut „	1	119 0	...	136 0
EGGS:				
Country ... per doz.	1	1 6	1 9	2 2
	2	1 4	1 7	2 0
Irish ... ... per 120	1	13 11	15 8	17 6
	2	12 7	14 10	16 9
„ (Stored) ... „	1	...	...	...
	2	...	...	...
„ (Duck) ... „	1	13 3	13 11	15 5
	2	12 7	12 9	...
Argentine ... „	1	...	...	...
Belgian... ... „	1	...	14 6	16 11
	2	...	...	...
Canadian ... „	1	...	...	...
Chinese... ... „	1	...	...	13 6
	2	...	...	12 6
„ (Duck) „	1	...	...	...
Danish ... ... „	1	15 4	16 11	19 8
	2	13 9	14 10	17 5
Dutch ... ... „	1	...	14 9	16 11
	2	...	...	...
„ (Pickled) „	1	...	...	...
„ (Duck) ... „	1	...	...	...
Egyptian ... „	1	7 11	...	...
	2	7 3	...	...
Polish ... ... „	1	9 9	12 0	12 6
	2	9 3	11 8	12 1
Russian ... „	1	10 3	11 11	13 9
	2	9 9	11 2	13 6

Average Prices of Potatoes at Dundee, Edinburgh, and Glasgow.

(Compiled from Reports received from the Board's Market Reporters.)

Market.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Langworthy and Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Langworthy and Golden Wonder.	Late Varieties. Other Soils. Other.
		per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
June.							
Dundee ...	1	...	...	...	...	...	4 5 0
	2	...	...	...	...	...	...
Edinburgh ...	1	...	...	...	...	7 17 0	6 10 0
	2	...	...	...	...	...	...
Glasgow ...	1	22 0 0	...	11 16 0	9 14 0	7 9 0	5 13 0*
	1	...	...	...	...	...	4 16 0†
July.							
Dundee ...	1	8 10 0	...	...	...	...	3 0 0
	2	...	...	...	...	...	...
Edinburgh ...	1	10 12 0	...	...	...	...	...
	2	...	...	...	...	...	...
Glasgow ...	1	11 9 0	...	...	...	...	...
	2	...	...	...	...	...	...
August.							
Dundee ...	1	6 8 0	...	...	...	...	...
	2	...	...	...	...	...	...
Edinburgh ...	1	7 4 0	...	...	...	...	...
	2	...	...	...	...	...	...
Glasgow ...	1	7 8 0	7 16 0	...	...	...	...
	2	...	...	...	...	...	...

* Kerr's Pink. † Arran Chief.

AVERAGE PRICES OF ROOTS, HAY, STRAW, AND MOSS LITTER, AT DUNDEE, EDINBURGH, AND GLASGOW.

(Compiled from Reports received from the Board's Market Reporters.)

Market.	Quality.	Roots.			Hay.		Straw.			Moss Litter.
		Carrots.	Yellow Turnips.	Swedes.	Rye Grass and Clover.	Timothy.	Wheat.	Barley.	Oat.	
		per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.	per ton s. d.	per ton. s. d.	per ton. s. d.	per ton. s. d.
					JUNE.					
‡ Dundee ...	1	...	...	38 0	130 0†	...	57 6	52 6	63 9	51 9*
	1	...	...	...	111 3	...	...	...	...	...
‡ Edinburgh	1	...	...	...	120 0†	...	55 0	...	55 0	44 0
	1	...	...	...	115 0	...	...	...	...	...
‖ Glasgow ...	1	...	...	...	90 0	95 0	53 9	...	46 3	39 5
					JULY.					
‡ Dundee ...	1	...	...	...	130 0†	...	57 6	60 0	63 0	51 0*
	1	...	...	...	100 0§	...	...	...	...	...
‡ Edinburgh	1	...	...	..	120 0†	...	55 0	...	55 0	44 0
	1	...	...	...	80 0§	...	...	...	...	...
‖ Glasgow ...	1	...	...	...	90 0	95 0	63 6	...	57 3	40 0
					AUGUST.					
‡ Dundee ...	1	...	...	...	115 0†§	...	63 9	...	61 3	51 3
	1	...	...	...	108 0§	...	...	...	...	...
‡ Edinburgh	1	...	...	...	120 0†	...	57 6	...	55 0	44 0
	1	...	...	...	85 0§	...	...	...	...	...
‖ Glasgow ...	1	...	...	...	90 0	95 0	65 0	...	60 0	38 9
	1	...	...	...	75 0§	...	...	...	...	...

* At Quay. † Baled and delivered. § New Crop.

‡ Quotations for Hay and Straw, delivered loose in town, except where otherwise indicated.

‖ „ baled Hay and Straw, f.o.r.

AVERAGE PRICES OF FEEDING STUFFS AT GLASGOW AND LEITH.

(Compiled from Reports received from the Board's Market Reporters.)

Description.	JUNE.		JULY.		AUGUST.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	12 15 0	12 5 0	13 0 0	12 6 0	13 3 9	12 12 6
Foreign	12 15 0	...	12 10 6	...	12 15 0	...
Decorticated Cotton Cake	13 10 0	...	13 10 0	...	12 9 2	...
Undecorticated Cotton Cake—						
Bombay (Home-manufactured)...	7 12 6	7 10 8	7 13 6	7 10 0	7 16 3	7 10 0
Egyptian (Home-manufactured). .	8 5 0	...	8 6 0	...	8 13 9	...
Palmnut Kernel Cake	..	...	10 7 6	..	10 7 6	...
Coconut Cake ...	...	...	12 10 0	..	12 10 0	..
Soya Bean Cake ...	..	...	11 10 0	..	11 10 0	...
Groundnut Cake—Undecorticated	*10 1 3	...	*10 4 0	...	*10 0 0	...
	**10 11 3	...	**10 14 0	...	**10 10 0	...
Maize Germ Cake—						
Home	12 2 6	..	12 10 0	...	12 8 4	...
Foreign	11 11 8	...	11 16 0	...	11 13 2	...
Maize Germ Cake Meal	10 15 0	..	12 2 6	...	..	...
Bean Meal	12 0 0	12 5 0	12 3 0	12 5 0	12 6 3	12 5 0
Maize Meal . .	12 3 9	11 17 6	11 13 0	11 7 0	12 15 0	10 15 0
	‡11 3 9	...	‡10 18 9	...	‡11 13 4	...
Rice Meal	8 0 0	...	8 1 0	...	8 0 0	...
Locust Bean Meal ...	10 6 3	10 0 0	10 3 9	10 0 0	10 10 0	10 0 0
Locust Beans (Kibbled and Stoned)	..	9 0 0	..	9 1 6	9 15 0	9 7 6
Maize Gluten Feed (Paisley) ...	9 10 0	..	9 6 0	...	10 8 2	...
Maize ...	§11 1 11	11 0 0	§10 17 0	10 12 0	§11 12 6	11 0 0
	‡11 5 0	..	‡10 17 6	..	...	...
Oats, Canadian—						
,, (No. 2 Feeds)	9 18 9	9 15 0	9 18 0	9 15 0	...	9 15 0
,, (No. 2 Western)	11 14 5	12 0 0	12 0 0	12 0 0	11 15 0	12 0 0
,, Plate	10 13 4	..	10 4 0	...	10 0 0	...
,, Home ...	12 3 9	10 7 6	12 4 0	10 15 0	12 7 6	10 15 0
Barley (Feeding) ...	11 16 8	11 0 0	12 0 0	11 0 0	11 8 9	11 0 0
Barley Bran ...	10 0 0	...	10 0 0	.	10 7 6	...
Malt Culms... ...	7 0 0	...	7 6 0	...	7 7 6	...
Distillery Mixed Grains—Dried	8 15 0	9 10 0	8 19 0	9 10 0	8 18 9	9 10 0
Brewers' Grains—Dried	8 10 0	8 0 0	...	8 0 0	...	8 0 0
Distillery Malt Grains—Dried . .	8 5 0	...	8 5 0	...	8 17 6	...
Wheat—						
Middlings (Fine Thirds or Parings)	10 0 0	8 5 0	10 3 0	8 12 0	10 7 6	9 0 0
Sharps (Common Thirds) ...	7 16 3	7 7 6	7 19 6	7 11 0	8 12 6	8 0 0
Bran (Medium) ...	7 9 5	6 17 6	7 15 0	7 3 0	8 3 9	8 0 0
,, (Broad) ...	7 15 8	7 16 3	8 0 0	8 2 0	8 11 3	8 15 0
Feeding Treacle ..	8 1 3	9 1 3	8 0 0	8 9 0	7 18 9	8 5 0
Crushed Linseed ...	30 0 0	...	29 12 0	...	29 10 0	...
Fish Meal	21 0 0	18 11 3	20 4 0	18 15 0	21 2 6	18 15 0
Beans—						
China	10 18 9	...	11 0 0	...	11 5 0	...
English	12 17 6	...	12 12 0	...	12 10 0	...
Rangoon White ..	10 12 6	...	10 15 0	...	10 15 0	...
Sicilian	11 5 0	...	11 4 0	...	11 1 8	...

* 37 per cent. Oil and Albuminoids. ** 40 per cent Oil and Albuminoids.
§ Plate. ‡ South African (Yellow).

Printed under the authority of HIS MAJESTY'S STATIONERY OFFICE
By J. Skinner & Co., Ltd., Thistle Street, Edinburgh.

INDEX TO VOL. VIII.—1925.

Date of issue.	Date of issue	Date of issue.